PRACTICAL
ENGINEER
Trade-mark reg. U. S. Pat. Office
SEMI-MONTHLY
VOL. XIX. CHICAGO, JANUARY 15, 1915 No. 2

# Air Lift for Water Supply

FROM 100 FT. BELOW THE SURFACE TO RESERVOIR, 2,000,000 GAL. IN 11 HR. BY CHARLES C. PHELPS

COTTON MILLS, and especially finishing works, require an abundant, cheap and reliable supply of pure water for bleaching, dyeing, mercerizing, soaping and washing solutions, for humidification, as well as for drinking and general purposes. The water furnished by an air lift system is therefore ideal, as the aeration of the water brought about by its contact with the compressed air actually results in a purifying action. The air lift system described in this article, which is installed at the plant of the United States Finishing Co., at Pawtucket, Rhode Island, is typical of its kind.

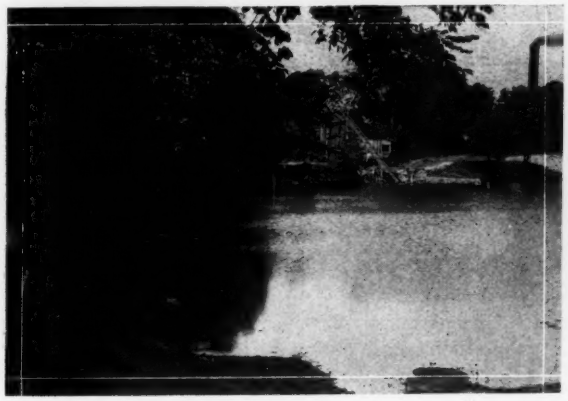


FIG. 1. RESERVOIR SUPPLIED FROM WELLS; COMPRESSOR HOUSE CHIMNEY IN THE BACKGROUND

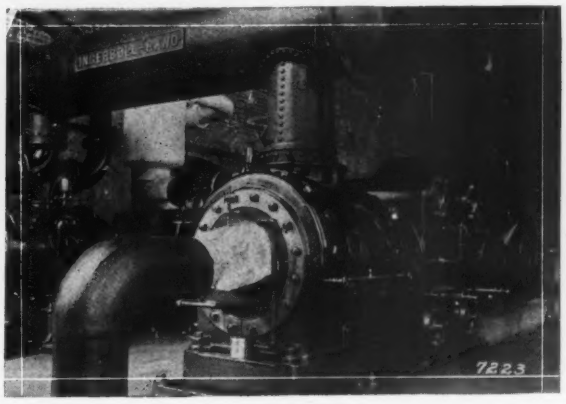



FIG. 2. INGERSOLL-RAND COMPRESSOR WHICH SUPPLIES AIR FOR THE LIFT

## SOURCE OF WATER

FORMERLY, a pond, Fig. 1, located near the works and fed by a spring, furnished the water supply; but this was found to be insufficient for the company's needs, so 17 wells were sunk, varying in depth from 117 to 300 ft., but one of these wells became "dead," leaving 16 in operation. The water level in the various wells differs; but it is understood that the average depth of the water level in the wells, when pumping, is over 100 ft. below the surface, the submergence of the pipe in each well, below the water level, being about 60 per cent of the total depth. In the daily run of 11 hr., these wells supply 2,000,000 gal. of water to the works, the principal consumption being in the bleach house.

## AIR SUPPLY

THE compressor which supplies the air for these wells is an Ingersoll-Rand, Corliss, steam-driven, 2-stage machine, with both steam and air cylinders compounded. The stroke is 24 in., steam cylinders 18 and 30 in. in diameter, and air cylinders 16¼ and 27¼ in. in diameter, with an intercooler mounted above and between the 2 air cylinders. The piston displacement of the air cylinders is rated at 1600 cu. ft. a min. at 106 r.p.m. with a final air pressure of 70 lb. gage.

This compressor was installed for operation at 125 lb. steam pressure and a vacuum of 26 in. mercury. Under these conditions, using dry saturated steam, the indicated horsepower of the unit is rated at 230. The live steam main is 6 in. in diameter and the steam exhaust is 10 in. in diameter, large sweeping bands being used for both the steam and air connections. Figure 2

shows the air compressor from the low-pressure side, and Fig. 3 the massive concrete double foundation on which the unit is mounted so as to bring it on a level with the ground. The floor of the compressor room is extended beyond these foundations by supporting it on iron brackets, as shown, the pit behind the compressor containing auxiliary apparatus and providing room for expansion.

Steam exhausts into an Alberger surface condenser, with 600 sq. ft. of cooling surface, to which is connected an air and circulating pump, having cylinders of 8, 10 and 10 in. by 12-in. stroke.

Twelve Bigelow boilers, each of 260 hp., are installed in battery in the boiler room, which immediately adjoins the compressor room. The boiler which supplies steam for the compressor carries about 130 lb. pressure, the others 90 lb. to supply steam for engines, pumps and other purposes. Hand stoking is employed, a track, elevated 2 or 3 ft. from the boiler room floor and running the entire length of the boiler room parallel with the battery of boilers, being used in connection with bottom dump cars for bringing in the coal supply.

FIG. 3. CONCRETE STILT FOUNDATION TO BRING COMPRESSION TO FLOOR LEVEL

### Air Distribution

Compressed air is discharged through an 8-in. pipe directly to a receiver, Fig. 7, placed in the yard a few feet from the compressor house. The cubical contents of this receiver is about 275 cu. ft., a pressure of 75 lb. per sq. in. being ordinarily maintained, which is sufficient to operate the wells satisfactorily, although the pressure must be increased to 90 or 100 lb. to start the wells running.

A 2-in. main running from the top of the receiver conducts air from the receiver to the works, where it is used for numerous purposes in connection with the singeing and mercerizing machines, for keeping pressure on a hydraulic elevator, for a "dry-pipe" sprinkler system and occasionally for cleaning purposes. Two drains below the receiver prevent any trouble from condensed moisture if opened 2 or 3 times a week.

The outlet shown in the end of the receiver in Fig. 7 is a 6-in. wrought iron main which carries the air to the wells, several hundred feet distant, all wells being controlled by a main valve in the air line near the wells, which is protected by a length of iron pipe, as shown in Fig. 7. This length of air piping has the same effect as additional receiver capacity and acts to keep a constant steady pressure at the wells, even when the demand for air fluctuates. It is laid so as to drain any condensed moisture back to the drain traps. Branch air lines, 1¼ in. diameter, lead from the air main to the bottoms of the individual wells, and each well has a plug cock in the air line so that it can be cut out if desired. The water pipes in the wells vary in diameter from 2 to 4¼ in., depending upon the capacity of each well.

The air lift is of the Harris "Twentieth Century" type. As the water is lifted from each well it strikes the under side of a mushroom-shaped discharge plate, known as a deflector head, and falls into a concrete pit, as illustrated in Fig. 6. Wooden covers are placed over these pits. The water from the various wells flows by gravity into a 12-in. water main leading to the bleachery, or, when the full supply of water from the wells is not required there, the excess overflows into the storage reservoir, whence it is taken by steam pumps for the boilers and other purposes about the plant. The water overflow valve is shown on the left side of Fig. 7.

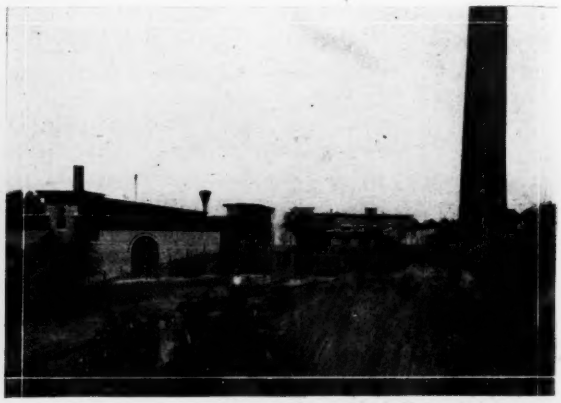


FIG. 4. NEAR VIEW OF COMPRESSOR AND BOILER HOUSE

It has often been stated that the air life system of pumping is adapted principally for very deep wells and for very high lifts. While this is true, as far as the statement goes, it is also a fact that the air lift will often show a much better economy in wells of moderate depth than any other method of pumping. The system described in this article certainly makes a favorable showing, which is largely due to the fact that each well shares the efficiency of the large efficient compressing unit, as there are practically no losses in power transmission.

Other considerations are sometimes of even greater importance than economy. In a textile finishing plant, for instance, a failure in the water supply would mean a big loss in production. The supply from an air lift system is dependable as long as there is water to be pumped. Moreover, air lifts keep the water bearing cavity open and so tend to increase the yield of the well. Perhaps one of the greatest benefits in any air lift system is the fact that it requires no attention when once properly installed and there can be no trouble from wear and leakage due to sand or grit in the water, inasmuch as there are no moving parts whatever in the well to get out of order.

### Editorial Comment

A consideration of proportions in the plant above described will be of interest as showing something of the proper design for one successful air lift pumping system.

The 2,000,000 gal. supply in 11 hr. works out to the rate of 3030 gal. per min., and as the compressor supplies 1600 cu. ft. of air per minute, this gives 1.9 gal. pumped per cubic foot of air supply. Since part of the air is used for general purposes in the works, it is probably safe to assume 2 gal. per cu. ft. of air.

On the average, the height of lift from the water surface to the ground level is 100 ft., and as there is 60 per cent submergence, this would give the average depth from ground level to the bottom of the air pipe as 250 ft. Dividing this by the pressure used at the well, 75 lb., would give 3.34 ft. as the total lift per pound of pressure, under a 60 per cent submergence condition. This is only a rough figure, as the lift and submergence would vary in the different wells, but it will give an approximate idea of the proportions. The starting pressure is from 90 to 100 lb., as against a running pressure of 75 lb., or, in other words, the starting pressure is 1.2 to 1.3 times the running pressure.

Supply pipe from the receiver to the wells is 6 in. diameter, and would have an area approximately of 0.196 sq. ft. Assuming 1400 cu. ft. of air supplied per minute to the wells, this would mean a velocity of 4400 ÷ 0.1963, or 7430 ft. per minute of air in the supply pipe. The flow pipe from the wells to the works is a 12-in. with area of 0.785 sq. ft., and the water supplied would be 406 cu. ft. per min. (3030 × 0.134) and dividing the cubic feet per minute by the area of the pipe gives 518 ft. per min. as the velocity of the water in the pipe. The velocity allowance would, of course, depend on the incline of the pipe from the wells to the works.

Four hundred and six cubic feet multiplied by 62.5, the weight per cubic foot, and by 100, the distance lifted from the surface of the water to the ground, and divided by 33,000 would give the water horsepower, and works out to 76.85. As the indicated horsepower of the steam cylinder of the compressor is given as 230, this would give an efficiency from the indicated horsepower in the steam cylinder to the power used in lifting water of 0.3335, which is a very good result when the losses between these 2 points are taken into account.

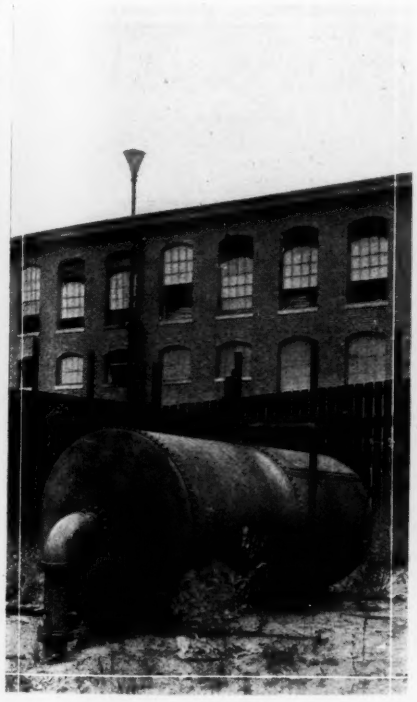


FIG. 5. AIR RECEIVER WITH OUTLET TO WELLS IN FOREGROUND; OUTLET TO WORKS AT TOP

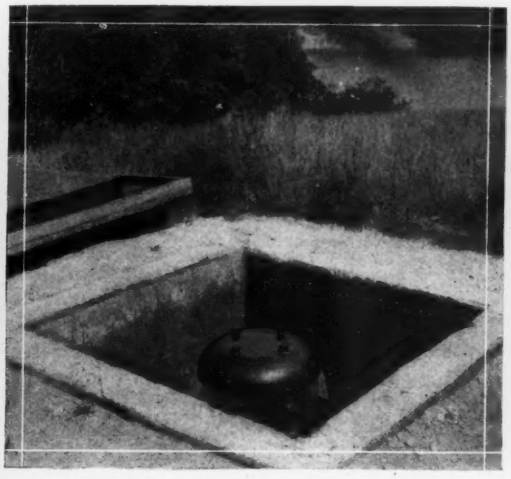


FIG. 6. DISCHARGE HEAD AND PIT

FIG. 7. OPERATING CONTROL VALVE ON AIR LINE TO WELLS. THE OTHER VALVE IS ON THE WATER MAIN WHICH RUNS TO ONE OF THE WELLS IN THE MOUND AT THE REAR

U. S. Civil Service Commission announces an examination on Feb. 3, 1915, for temporary employment as topographic aid under the Geological Survey during the field season, entrance salaries ranging from $40 to $75 a month. Appointment to permanent positions will be made only of persons who qualify in and are certified from the junior topographer examiner. Competitors will be examined in mathematics, surveying, topographic drawing, letter writing, training and experience. Applicants must have reached their twentieth but not their fortieth birthday on the date of the examination. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312.

# A Portable Machine Shop

MOTOR MOUNTED ON TRUCK AND PROVIDED WITH FLEXIBLE EXTENSION SHAFT AND VARIOUS HEADS SERVES MANY PURPOSES IN THE PLANT. BY J. C. HAWKINS

IN the average large power plant the master mechanic or chief engineer is sometimes called upon to perform almost impossible jobs in repairing machinery, and many times the nature of the work is such that it cannot be easily taken to the machine shop, but instead the machine shop must be brought to it. After worrying along with ratchet drills and other similar tools for some time in doing repair work in the slow, old way, we devised a portable machine shop that has saved its cost many times over in the last few years in doing this work.

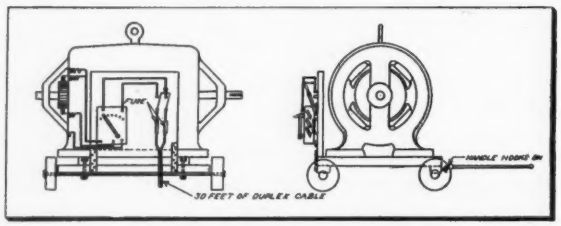



FIG. 1. VIEWS OF PORTABLE MOTOR USED FOR REPAIR WORK

This equipment consisted of an idle 5-hp., shunt-wound, direct-current motor, mounted on a truck, and used to drive the tools through a flexible shaft. Figure 1 shows the motor which was bolted to a 4-wheel truck. A starting box was mounted on a board on the back of the truck having a switch and fuse block, and to which was connected about 30 ft. of flexible duplex cable, the other end of which was fitted with blades, which could be pushed into the jaws of any convenient switch.

We then purchased an 8-ft. length of flexible shaft of a size warranted to transmit 1 hp. This shaft is composed of close-wound helical steel springs, wound one

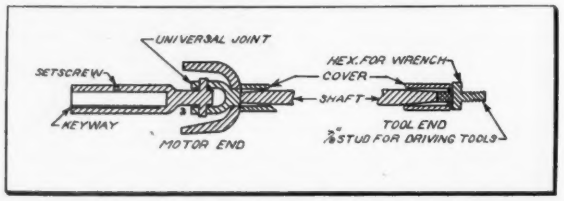



FIG. 2. END FASTENINGS OF FLEXIBLE SHAFT

over the other, part being wound right-handed, and part wound left-handed. This prevents them from unwinding, and yet the shaft is flexible and will turn while being bent.

The whole shaft turns in a leather-covered casing, which is made of a helical-wound steel coil of larger diameter. The ends of the flexible shaft are shown in Fig. 2. The end that connects to the motor is bored to slip over the end of the ¾-in. motor shaft, and had a ⅜ by ⅜-in. key to prevent turning and a set screw to hold it in place, as shown. The end of the helical shaft is tapered, and brazed into a socket, the end of which forms one-half of the knuckle joint. The bell-shaped guard is held in place by being screwed onto the socket before the cover is put on and prevents the knuckle joint from bending far enough to get tangled up. The driven end of the shaft is also brazed into a socket, the end of which is drilled and tapped to receive the stud on the end of the coupling, the other end of which is threaded, and is connected to the tool to be driven. The coupling is made larger in the center to act as a shoulder to drive against, and is made hexagonal for the use of a wrench in disconnecting the shaft or taking it apart. The receiving end of the tool is also made hexagonal so that it may be easily disconnected, as the coupling screws in against the shoulder. There is also a ¼-in. hole drilled through the shaft and casing, into which a pin is inserted to prevent the shaft from turning when taking it apart. When properly lubricated with a light grease, the cover will not turn with the shaft.

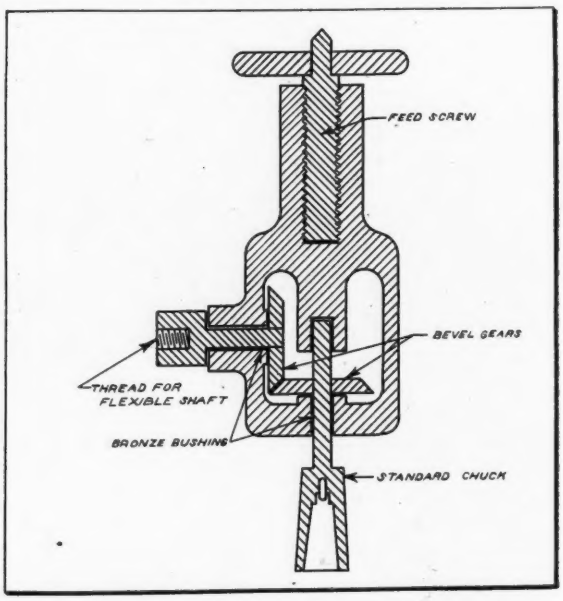



FIG. 3. DRILL HEAD USED WITH FLEXIBLE SHAFT

The drill head used for drilling, reaming, etc., is shown in Fig. 3, and is so simple that it needs little explanation. The gears are of such size that the chuck runs ⅓ as fast as the motor. The chuck is designed for the standard Morse taper shank drill. The overall length without drill is 14 in. and will take up to 1½-in. drill. The length of the feed screw is 5 in. The speed of the motor is 460, which, when used on the drill head, gives a drill speed of about 153. This is too high for some work and too low for some, but gives fairly good results and is far better than the old hand ratchets.

One of the jobs on which this drill was used was in patching a cracked cast-iron feed-water heater which required 76 ⅝-in. bolt holes to be drilled through the shell. Another job was drilling 16 1½-in. holes through a rolling mill housing 22 in. thick. The drill is stopped and started by stopping or starting the motor. Some of

these shafts are fitted with a clutch in the tool end, so arranged that the tool can be stopped without stopping the motor. This machine gives only one speed; a variable speed motor and controller could be used to better advantage, but none was to be had at the time this outfit was made, and it works so well that it never has been changed.

Another use to which this machine was put was in removing the shoulders from the ends of a badly worn engine cylinder. The 8-in. emery wheel, shown in Fig. 4, was used and the job smoothed up with a file. This was much easier, and took less time than chipping and filing the shoulders down. The "old man" used for holding the drill head is shown in Fig. 6. One of them is a Z-shaped piece of 1 by 2-in. iron with several bolt holes, and the other is made adjustable, and can be used in almost any position. The post is extra heavy hydraulic pipe, and the arms are held by setscrews. The brace

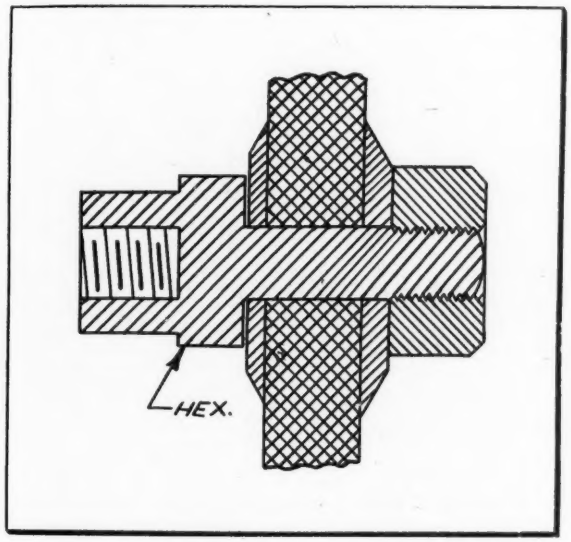



FIG. 4. EMERY WHEEL ATTACHED TO FLEXIBLE SHAFT

may be clamped to a flat plate by adjusting the middle arm and using the clamping screw to hold it.

After several years' use the tube cap faces on the headers of the B. & W. boilers became in bad condition and it was hard to make the caps stay tight. A head was made as shown in Fig. 5, on which was used a ½ by 6-in. steel disk, to which was glued a sheet of emery cloth. This was held against the header and the surface ground true. The reason that a steel disk was used instead of using an emery wheel was that the emery wheel would wear out of true and would not give a true surface.

There is a knuckle joint and a spring on the head which allows the grinder to press squarely on the header, even though the shaft is not held exactly square with the header. In every case the motor was connected to the most convenient switch. When used on the front of the boilers the handle of the truck was disconnected and the motor hoisted with a differential chain hoist to a convenient position.

Another use for this outfit was in running a chipping and calking tool. One of the heavy punch machines was to be changed and it was necessary to chip a spot on the casting about 12 by 17 in. and 1½ in. deep on one side. The casting weighed 3 tons and could not be moved to the shop. The chipping tool (not shown) was connected to the shaft and the work done in a short time. In making repairs on a traveling crane, the motor was hoisted onto the bridge and the drilling, etc., done in a short time. A cylinder boring bar was made, to be driven by this outfit through reducing gears.

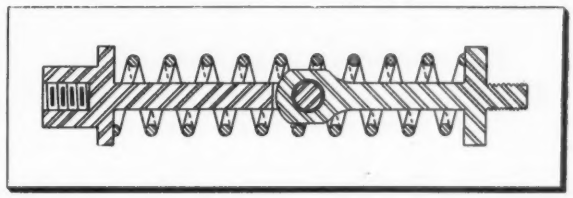


FIG. 5. CAP CLEANING HEAD

These are only a few of the many uses to which this outfit was put. The flexible shaft is quite expensive and, as the motor was too large for it, it was broken by having a large drill bind, thereby overloading it, and one casing was worn out, due partly to insufficient lubrication and not keeping the shaft clean. It should occasionally be taken apart and washed with coal oil and greased with a thin grease. The shaft will work when bent double, but will not last as long and will soon wear out the casing. One man can pull the truck any place and 4 men can easily carry it.

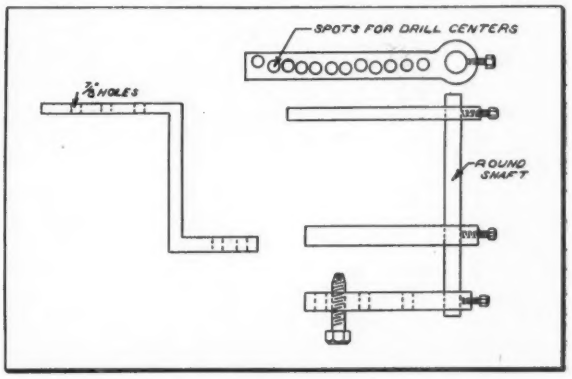



FIG 6. BRACES FOR HOLDING DRILL HEAD

---

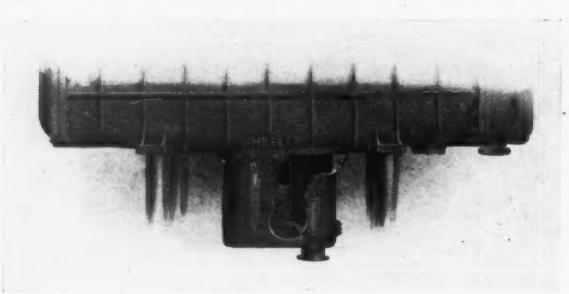
U. S. CIVIL SERVICE COMMISSION announces an examination for physical laboratorian, on Feb. 3, 1915, to fill a vacancy at $3.04 a day in the Navy Yard, New York, N. Y. The following subjects will have the relative weights indicated: Practical questions, 60; training and experience, 40. Applicants should have a good knowledge of geometry and plane trigonometry, and sufficient technical education to insure a good knowledge of strength of structural materials (particularly iron and steel), of elementary physics and mechanics, and some technical experience involving the above subjects. Age, 20 yr. or over on the date of the examination. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312, stating the title, Physical Laboratorian (Male).

# Continuous Check on Steam Consumption

AN interesting feature in connection with the installation of the 5000-kw. turbine which was last year placed in the Liberty St. power plant of the Central Illinois Light Co. of Peoria, Ill., is the indicating hot well as supplied by the Wheeler Condenser and Engineering Co., of Carteret, N. J.

Furnished as a part of the surface condenser, this hot well measures the rate of steam condensation, and therefore the steam consumption of the turbine exhausting into the condenser. Ordinarily steam consumption cannot be measured unless elaborate testing apparatus, tanks and scales, together with complicated and troublesome piping are installed.

As shown by the accompanying illustration, this hot well is bolted directly to the bottom of the condenser and is divided into 2 compartments; at the left is the receiving chamber and at the right the suction chamber. These 2 compartments are separated by a wall or partition in which is inserted a brass orifice finished and polished to give it a high degree of accuracy.



INDICATING HOT WELL ATTACHED TO SURFACE CONDENSER

Calibrated by an independent factory test, a special scale etched upon steel is attached to the indicating gage glass and reads directly in pounds of steam per hour, this scale indicating the height of the condensate in the collecting well, or in other words, the head upon the orifice. By taking simultaneous readings of the hot well indicator and an indicating kilowattmeter and dividing the former by the latter, the steam consumption per kilowatt-hour is obtained.

In an exhaustive test made last fall on the above-mentioned unit by C. A. Hoppin, general superintendent, and O. H. Henschel, superintendent of power plants of the Central Illinois Light Co., it was found that at from half load to full load the readings obtained by means of the hot well indicator and an indicating wattmeter corresponded exactly with the readings of a high grade steam flow meter. From no load to half load the error was no more than 5 per cent.

ELECTRIC POWER CLUB has been formed, made up of manufacturers of motors and electrical power generators, with the object of advancing and improving the use of electric power. An interesting booklet has been issued, giving the names of the members, constitution of the club, and a classification of motors according to kind of current used and the driving purposes for which they are adapted. The secretary of the club is C. H. Roth, 1410 West Adams St., Chicago.

# Centrifugal Pumps for Boiler Feed Service*

ECONOMY RESULTING FROM USE OF THIS TYPE OF PUMP; CONSTRUCTION OF PUMPS. BY E. S. ADAMS

IN recent years there has been a considerable amount of experimenting with centrifugal pumps for small capacities and high heads, such as are encountered in boiler feed work, and now, due to the rapid strides that the manufacturers have made, these pumps are common in modern power plants, where the capacities run over 1750 boiler hp.

One of the first centrifugal pumps of real commercial merit, if not the first installed, was that placed in a large paper mill. This plant had a boiler capacity of 12,000 boiler hp., with a pressure of 140 lb.

A short time before they considered the installation of a centrifugal boiler feed pump. They had installed a cross-compound condensing Corliss engine with generator, on which they obtained an economy of about 12 lb. of steam per indicated horsepower per hour, and as they had an excess of electrical power they decided to put in a motor-driven centrifugal pump. This was a 4-stage De Laval pump, designed for a capacity of 1080 gal. per min. against a total head of 380 ft., or 165 lb. A great deal of attention was given to the difference between the steam and water pressures, and this was figured low to make the units as economical as possible.

With an economy of 12 lb. of steam per indicated horsepower per hour, and with allowance for the engine efficiency, the efficiency of the motor, and the efficiency of the pump, the centrifugal pump took about 25 lb. of steam per water horsepower per hour.

Inasmuch as this pump of course did not operate continuously with full capacity, which was figured with a margin of safety of 50 per cent over the normal rating of the boilers, it was assumed that a safe figure for the economy of the centrifugal pump would be not more than 35 lb. of steam per water horsepower per hour.

The pump was installed with a suction head of about 6 ft., the water handled being at a temperature of about 210 deg. F., no back pressure being carried on the heater. This pump has now been operating for 8 yr., and the only repairs have consisted of one thrust bearing and a complete set of wearing rings, a total charge of about $100. The complete cost of the equipment was between $3800 and $4000.

The conditions in this case were, of course, somewhat peculiar, in that they had a sufficient supply of exhaust steam for heating their feed water without the use of exhaust steam from their boiler feeders. The ordinary plant, however, especially in a central station, condenses all the steam from the main units and runs the auxiliaries noncondensing, using this steam for heating water.

There is practically no limit to the size a turbine-driven boiler feed pump can be built. In other words, we have boiler feed pumps operating at a capacity as low as 10 gal. of water per min. against 250 lb. pressure, and as high as 1600 gal. of water per min. against 280 lb. pressure.

*From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers.

With regard to capacity, we ordinarily take the normal rated capacity of the boilers and add 50 per cent to that for the capacity of the pump. In other words, a 10,000-hp. boiler having a normal feed of about 600 gal. of water per min. would be supplied with a pump having a capacity of 900 gal. per min.

With regard to the water pressure, we have ordinarily figured our pumps with a differential of from 25 to 30 lb. where the conditions cannot be closely approximated. We have made this differential as high as 60 lb., but in such cases we have departed from our general rule mainly on account of preference of the buyer.

Where a turbine pump feeds more than one battery of boilers, and may obtain its steam supply from one battery and supply water to another battery, we have always specified that if the normal steam pressure should be 150 lb., the turbine shall carry its full load on as low as 100 lb. pressure, and in some cases we have gone as low as 70 lb. This feature can be obtained by supplying auxiliary shut-off valves and nozzles, which are used only in cases of low steam pressures. It is always a good idea to get as much head as possible on the suction side of a centrifugal pump handling hot water, 10 ft. being considered a good average, although there are some pumps operating with a head on the suction side as low as 3 ft. In these cases, however, the conditions are rather constant, and the load does not fluctuate much, and there is practically no possibility of entrained air being carried into the pump.

We have had some trouble in connection with pitting of the suction vanes of a centrifugal pump handling hot water, but the cause of this trouble has been located and entirely overcome.

There are a few fundamental features in connection with centrifugal pumps in general and centrifugal boiler feed pumps in particular which determine whether an installation is going to be satisfactory or not.

On account of the high pressures encountered, it is exceedingly important to provide removable bronze wearing rings on both the impeller and casing at the joint between the suction and discharge chambers. There should also be bronze sleeves over the shaft, and removable stationary sleeves in the casing between the impellers, these being bronze in all cases.

On account of the possibility of the boiler pressure decreasing, which will decrease the pressure against which the pump is to operate, and on account of the further fact that at this time there is a great demand for feed water, the pump should be so designed that, regardless of the head against which it is to operate, the horsepower taken by it will not exceed a certain predetermined amount. This is especially true with motor-driven pumps, but also applies to turbine-driven pumps as serious overload, due to enormously increased capacities which are obtained on some designs of pumps when the pressure is dropped, sometimes destroys the turbine.

In a properly designed centrifugal pump it is impossible to build up a pressure in excess of a pre-determined head, which is known as the shut-off pressure, and beyond which the pressure will not go. One of the most advantageous points is the entire absence of shock or pulsation. The pressure is built up gradually and when the boiler feed regulator opens there is no hammer in the line, the pressure is always ready to force the water into the boilers. In case the water should become too hot or should not flow, there is no danger that the pump will wreck itself. Another point is the absence of vibration; and consequently light and inexpensive foundations only are required for a turbine-driven centrifugal pumping unit; incidentally this means a small amount of floor space required.

We have found by actual experience that practically the only bar to the continuance of efficiency by a centrifugal pump is leakage back from one stage to another, or in the case of a single stage pump, leakage back to the suction side. The labyrinth rings are a development of many years of experimenting, and it has been found that by this type of ring the leakage is practically nil. Of course, in water containing a certain amount of grit, there will, after a time, be some leakage, which necessarily grows worse as time goes on.

---

# Little Leaks

By Alfred W. Conklin

IT'S the little leaks that count,
Make the coal bill mount and mount,
Holes in fire and settings too,
Play the deuce with $CO_2$.
You can stop them—make them nil—
And help reduce that big coal bill.

Don't walk round with listless tread,
Be wide awake and think instead.
You're getting paid for what you do.
The boss has put it up to you
To find the leaks. Don't rest until
You've found them all, and cut that bill.

Fix your fires and keep them bright,
Point your settings, make them tight.
Watch the gases from your stack
Have them hazy, not jet black.
Use your damper with a will
And help reduce that big coal bill.

Draw up the joints that won't hold steam,
The valves reseat, make bright-work gleam.
Your chance is great for better pay,
Roll up your sleeves and start today
To plug the leaks. Keep plugging till
You've helped the boss reduce that bill.

And now your work grows new each day,
Monotony has given way
To interest keen and fresh delight,
In keeping fires and settings right.
Your stoking, too, is easier still
Because you've cut that big coal bill.

---

U. S. Civil Service Commission announces an examination for copyist electrical draftsman, on Feb. 3, 1915, to fill a vacancy at $3.28 in the Navy Yard, New York, N. Y., and vacancies in positions at $3.04 a day in the Navy Yard, Philadelphia, Pa., and the Puget Sound Navy Yard, Bremerton, Wash. Age, 18 yr. or over on the date of the examination. Apply for Form 1312.

# Electrical Machinery and Appliances

*For Generating, Transmitting and Using Current*

# Electrification of the Puget Sound Lines of the Chicago, Milwaukee & St. Paul Ry.

FIRST ELECTRIFIED STEAM ROAD TO OPERATE ON 3000 V. DIRECT CURRENT; LOCOMOTIVE MOST POWERFUL BUILT

PLANS for the electrification of the first engine division of the Chicago, Milwaukee & St. Paul Railway have now been completed and contracts let to the General Electric Co. for the electric locomotives, substation apparatus and line material, and to the Montana Power Co. for the construction of the transmission and trolley lines. This initial electrification of 113 miles of main line between Three Forks and Deer Lodge is the first step toward the electrification of 4 engine divisions extending from Harlowton, Montana, to Avery, Idaho, a total distance of approximately 440 miles, aggregating about 650 miles of track, including yards and sidings. While this comprises the extent of track to be equipped in the near future, it is understood that plans are being made to extend the electrification from Harlowton to the coast, a distance of 850 miles, should the operating results of the initial installation prove as satisfactory as anticipated.

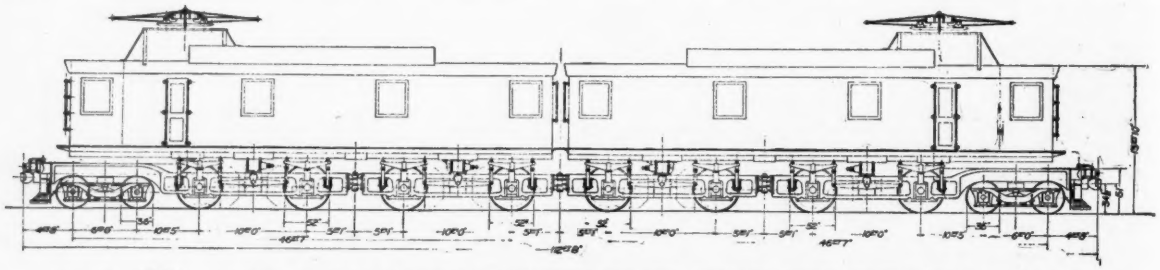


FIG. 1. 3000-V. DIRECT-CURRENT ELECTRIC LOCOMOTIVE FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

The various terminal and tunnel installations have been made necessary, more or less, by reason of local conditions; but the electrification of this road is undertaken purely on economic grounds with the expectation that superior operating results with electric locomotives will effect a sufficient reduction in the present cost of steam operation to return an attractive percentage on the large investment required. If the anticipated savings are realized in the electric operation of the road, this initial installation will constitute one of the most important milestones in electric railway progress, and it should foreshadow large future developments in heavy steam road electrification.

The first step taken towards electrification by the Chicago, Milwaukee and St. Paul Railway was to enter into a contract with the Montana Power Co. for an adequate supply of power over the 440 miles of main line considered for immediate electrification. The Montana Power Co. covers a great part of Montana and part of Idaho with its network of transmission lines, which are fed from a number of sources, of which the principal ones are tabulated below:

Madison River, 11,000 kw.; Canyon Ferry, 7,500 kw.; Hauser Lake, 14,000 kw.; Big Hole, 3,000 kw.; Butte, steam turbine, 5,000 kw.; Rainbow Falls, 21,000 kw.; Small powers aggregating 7,390 kw.; total power developed, 68,890 kw.

Further developments, part of which are under construction, are as follows:

Great Falls, 85,000 kw.; Holter, 30,000 kw.; Thompson Falls, 30,000 kw.; Snake River, 20,000 kw.; Missoula River, 10,000 kw.; total, 175,000 kw.

Total power capacity developed and undeveloped, 244,000 kw.

The several power sites are interconnected by transmission lines, supported on wooden poles and operating at 50,000 v. for the earlier installations, and on steel towers and operating at 100,000 v. for later installations. Ample water storage capacity is provided in the Hebgen Reservoir of 300,000 acre-feet, supplemented by an auxiliary reservoir capacity at the several power sites, which brings the total up to 418,000 acre-feet. The Hebgen Reservoir is so located at the head waters of the Madison River that water drawn from it can supply in turn the several installations on the Madison and Missouri Rivers, so that the same storage capacity is used a number of times, affording an available storage capacity considerably greater than is indicated by the figures

given. It would seem, therefore, in changing from coal to electricity as a source of motive power, that the railroad is amply protected in respect to the reliability and continuity of the power supply.

Due to the great facilities available and the low cost of construction under favorable conditions existing, the railway company will purchase power at a contract rate of $0.005,36 per kw.-hr., based on a 60 per cent load factor. It is expected under these conditions that the cost of power for locomotives will be considerably less than is now expended for coal. The contract between the railway and power companies provides that the total electrification between Harlowton and Avery, comprising 4 engine divisions, will be in operation Jan. 1, 1918.

In order to connect the substations with the several feeding-in points of the Montana Power transmission lines, a tie-in transmission line is being built by the railway company that will permit feeding each substation from 2 directions and from 2 or more sources of power. This transmission line will be constructed with wooden poles, suspension type insulators, will operate at 100,000 v. and will follow, in general, the right of way of the railway company except where advantage can be taken of a shorter route over public domain to avoid the necessarily circuitous line of the railway in the mountain districts.

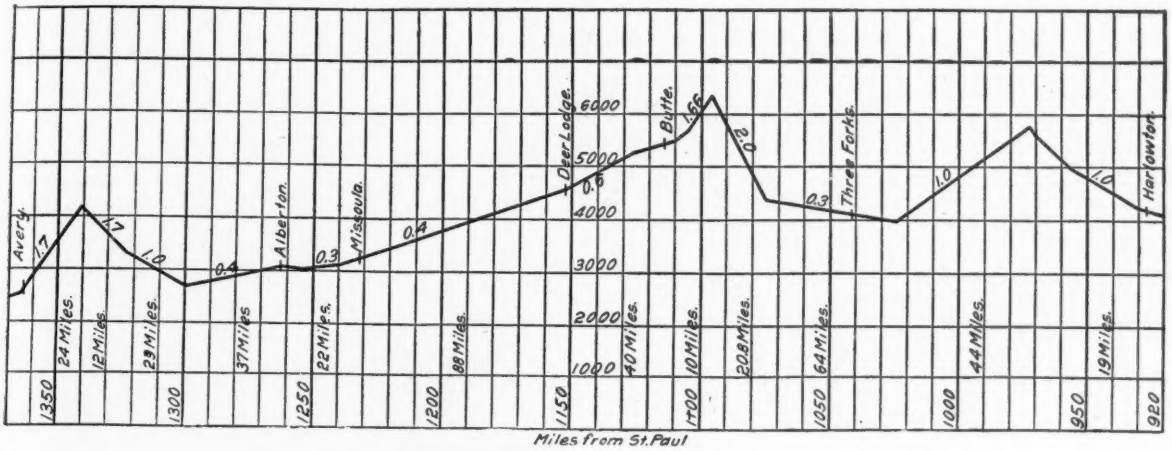



FIG. 2. PROFILE OF PRESENT AND PROPOSED ELECTRIFICATION DIVISIONS

The immediate electrification of 113 miles will include 4 substations containing step-down transformers and motor-generator sets with necessary controlling switchboard apparatus to convert 100,000-v., 60-cycle 3-phase power to 3000 v. direct current. This is the first direct-current installation using such a high potential as 3000 v., and this system was adopted in preference to all others after a careful investigation extending over 2 yr. The 2400-v., direct-current installation of the Butte, Anaconda & Pacific Railway in the imme-

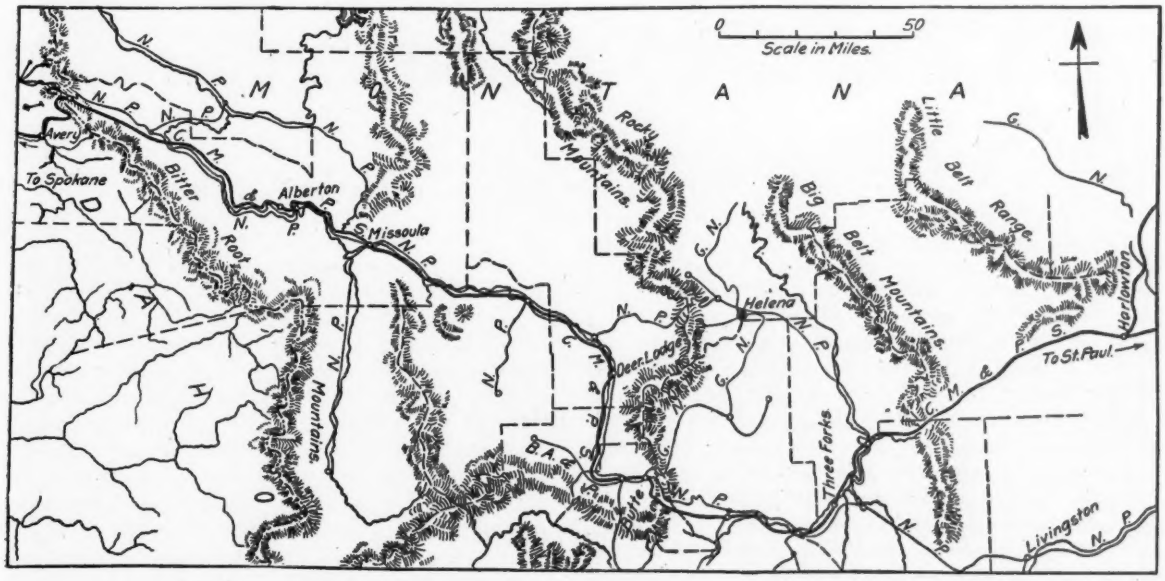



FIG. 3. RAILROAD MAP OF THE PRESENT AND PROPOSED ELECTRIFICATION DIVISIONS

diate territory of the proposed Chicago, Milwaukee & St. Paul electrification has furnished an excellent demonstration of high-voltage direct-current locomotive operation during the past year and a half.

Equipment for this road was also furnished by the General Electric Co., and a comparison based on 6 months' steam and electric operation shows a total net saving of more than 20 per cent on the investment or total cost of the electrification. These figures, of course, do not take into account the increased capacity of the lines, improvement to the service and the more regular working hours for the crews. The comparison also shows that the tonnage per train has been increased by 35 per cent, while the number of trains has been decreased by 25 per cent with a saving of 27 per cent in the time required per trip.

### Substations

The substation sites of the Chicago, Milwaukee & St. Paul electrified zone provide for an average intervening distance of approximately 35 miles, notwithstanding that the first installation embraces 20.8 miles of 2 per cent grade westbound and 10.4 miles of 1.66 per cent grade eastbound over the main range of the

FIG. 4. FREIGHT TRAIN ASCENDING RULING 2 PER CENT GRADE BETWEEN PIEDMONT AND DONALD

Rocky Mountains. With this extreme distance between substations and considering the heavy traffic and small amount of feeder copper to be installed, it becomes apparent that such a high potential as 3000 v. direct current permits of a minimum investment in substation apparatus and considerable latitude as to location sites.

The substations will be of the indoor type, transformers being 3-phase, oil cooled, and reducing from 100,000 v. primary to 2300 v. secondary, at which potential the synchronous motors will operate. The transformers will be rated 1900 and 2500 kv.-a., and will be provided with 4 2½ per cent taps in the primary and 50 per cent starting taps in the secondary.

The motor-generator sets will comprise a 60-cycle synchronous motor driving 2 1500-v., direct-current generators connected permanently in series for 3000 v. The fields of both the synchronous motor and direct-current generators will be separately excited by small generators direct connected to each end of the motor-generator shaft. The direct-current generators will be compound wound, will maintain constant potential up to 150 per cent load and will have a capacity for momentary overloads up to 3 times their normal rating. To insure good commutation on these overloads, the generators are equipped with commutating poles and compensating pole-face windings. The synchronous motors will also be utilized as synchronous condensers, and it is expected that the transmission line voltage can be so regulated thereby as to eliminate any effect of the fluctuating railway load.

The location and equipment of the several substations is as follows:

| Station | Miles from Deer Lodge | No. of Units | Kw. per Unit | Total |
|---|---|---|---|---|
| Morel | 17.1 | 2 | 2000 | 4000 |
| Janey | 50.5 | 3 | 1500 | 4500 |
| Piedmont | 77.9 | 3 | 1500 | 4500 |
| Eustis | 120.6 | 2 | 2000 | 4000 |

### Overhead Construction

Trolley construction will be of the catenary type, in which a 4/0 trolley wire is flexibly suspended from a steel catenary supported on wooden poles, the construction being bracket wherever track alinement will permit and cross-span on the sharper curves and in yards. Steel supports instead of wooden poles will be used in yards where the number of tracks to be spanned

FIG. 5. SUBSTATION SITE AT PIEDMONT, MONT.

exceeds the possibilities of wooden pole construction. Poles for the first installation are already on the ground and 30 mi. of poles are set. Work in this direction will be pushed with all speed and will be completed in the summer of 1915, ready for operation in the fall on the delivery of the first locomotives.

As the result of careful investigation and experiments, a novel construction of trolley will be installed, composed of the so-called twin-conductor trolley. This comprises 2 4/0 wires suspended side by side from the same catenary by independent hangers alternately connected to each trolley wire, a form of construction permitting the collection of heavy currents by reason of the twin contact of the pantograph with the 2 trolley wires, and also insuring sparkless collection under the extremes of either heavy current at low speed or more moderate current at high speeds. It seems that the twin-conductor type of construction is equally adapted to the heavy grades calling for the collection of heavy currents, and on the more level portions of the profile where maximum speeds of 60 m.p.h. will be reached with the passenger trains having a total weight of over 1000 tons. The advantage of this type of construction is due partly to the greater surface for the collection of current, but

largely to the great flexibility of the alternately suspended trolley wires, a form of construction which eliminates any tendency to flash at the hangers, either at low or high speed. Including sidings, passing and yard tracks, 113 mi. of route mileage is increased to approximately 168 mi. of single track to be equipped between Deer Lodge and Three Forks in the initial installation.

### Locomotives

The locomotives to be manufactured by the General Electric Co. are of especial interest for many reasons. They are the first locomotives to be constructed for railroad service with direct-current motors designed for so high a potential as 3000 v., will weigh approximately 260 tons and will have a continuous capacity greater

FIG. 6. TRACKS CROSSING MISSOURI RIVER AT LOMBARD

than any steam or electric locomotive yet constructed. Perhaps the most interesting part of the equipment is the control, which is arranged to effect regenerative electric braking on down grades. This feature as yet has never been accomplished with direct-current motors on so large a scale. The general characteristics as proposed are tabulated below:

| | | |
|---|---|---|
| Total weight | 260 | tons |
| Weight on drivers | 200 | " |
| Weight on each guiding truck | 30 | " |
| Number of driving axles | 8 | |
| Number of motors | 8 | |
| Number of guiding trucks | 2 | |
| Number of axles per guiding truck | 2 | |
| Total length of locomotive | 112 | ft. |
| Rigid wheel base | 10 | ft. |
| Voltage of locomotive | 3000 | |
| Voltage per motor | 1500 | |
| Horsepower rating 1 hr.—each motor | 430 | |
| Horsepower rating continuous—each motor | 375 | |
| Horsepower rating 1 hr.—complete locomotive | 3440 | |
| Horsepower rating continuous—complete locomotive | 3000 | |
| Trailing load capacity, 2 per cent grade | 1250 | tons |
| Trailing load capacity, 1 per cent grade | 2500 | " |
| Approximate speed at these loads and grades | 16 | m.p.h. |

From Harlowton to the coast, the Chicago, Milwaukee & St. Paul Railway crosses 4 mountain ranges: the Belt Mountains at an elevation of 5768 ft., the Rocky Mountains at an elevation of 6350 ft., the Bitter Root Mountains at an elevation of 4200 ft. and the Cascade Mountains at an elevation of 3010 ft. The first electrification between Three Forks and Deer Lodge calls for locomotive operation over 20.8 mi. of 2 per cent grade between Piedmont and Donald at the crest of the main Rocky Mountain Divide, so that the locomotives will be fully tested out as to their capacity and general service performance in overcoming the natural obstacles of the first engine division.

The initial contract calls for 9 freight and 3 passenger locomotives having the above characteristics and similar in all respects, except that the passenger locomotives will be provided with a gear ratio permitting the operation of 800-ton trailing passenger trains at approximately 60 m.p.h., and will, furthermore, be equipped with an oil-fired steam heating outfit for the trailing cars. The interchangeability of all electrical and mechanical parts of the freight and passenger electric locomotives is considered to be of great importance from the standpoint of operation and maintenance.

The cab consists of 2 similar sections extending practically the full length of the locomotive. Each section is approximately 52 ft. long and the cab roof is about 14 ft. above the rail, exclusive of the housings for ventilation. The trolley bases are about 5 ft. above the roof, owing to the unusual height of the trolley wire, which will be located at a maximum elevation of 25 ft. above

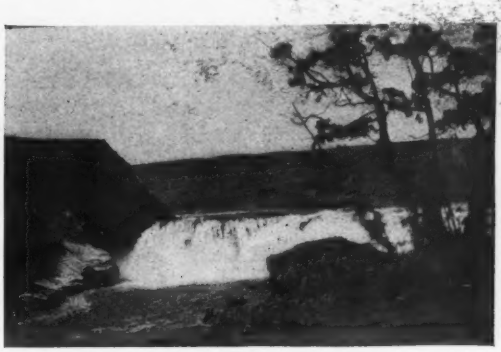


FIG. 7. SITE OF 60,000-KW. HYDROELECTRIC DEVELOPMENT AT GREAT FALLS, MONT.

the rail. The outer end of each cab will contain a compartment for the engineer, while the remainder is occupied by the electric control quipment, train heater, air brake apparatus, etc.

### Motors

Each of 8 motors for the complete locomotive will have a normal 1-hr. rating of 430 hp. with a continuous rating of 375 hp., thus giving the locomotives a 1-hr. rating of 3440 hp. and a continuous rating of 3000 hp., which makes it more powerful than any steam or electric locomotive ever built. The drawbar pull available for starting trains will approximate 120,000 lb. at 30 per cent coefficient of adhesion.

Each motor will be twin-geared to its driving axle, a pinion being mounted on each end of the armature shaft. The motor is of the commutating-pole type and has openings for forced ventilation from a motor-driven blower located in the cab.

The freight locomotives are designed to haul a 2500-ton trailing load on all gradients up to 1 per cent at a speed of approximately 16 m.p.h., and this same train load unbroken will be carried over the 1.66 and 2 per cent ruling grades on the west and east slopes of the Rocky Mountain Divide with the help of a second similar freight locomotive acting as pusher. Track provision is being made at Donald, the summit of the grade, to enable the pusher locomotive to run around the train and be coupled to the head end to permit electric braking on the down grade. In this case, the entire train will be under compression and held back by the 2 locomotives at this head end, the entire electric braking of the 2 locomotives being under the control of the motorman in the operating cab of the leading locomotive. It is considered that electric braking will prove valuable in this mountain railroading; for, in addition to providing the greatest safety in operation, it also returns a considerable amount of energy to the substations and transmission system, which can be utilized by other trains demanding power. In this connection, the electric locomotives will have electric braking capacity sufficient to hold back the entire train on down grade, leaving the air brake equipment with which they are also equipped

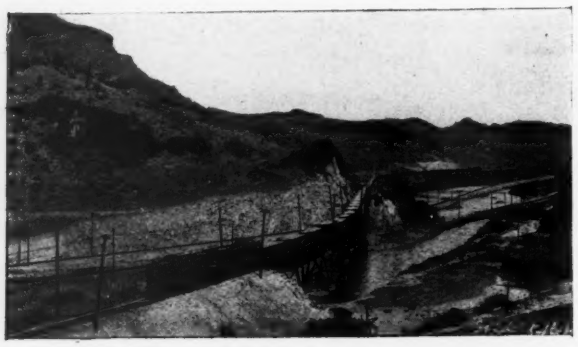


FIG. 8. ORE TRAIN ON THE ELECTRIFIED BUTTE, ANACONDA & PACIFIC AT SILVER BOW, CROSSING TRACKS OF THE NORTHERN PACIFIC

to be used only in emergency and when stopping the train. There is, therefore, provided a duplicate braking system on down grades, which should be reflected in the greatest safety of operation afforded and the elimination of a considerable part of break-downs, wheel and track wear and overheating with consequent reduction in maintenance and improvement in track conditions.

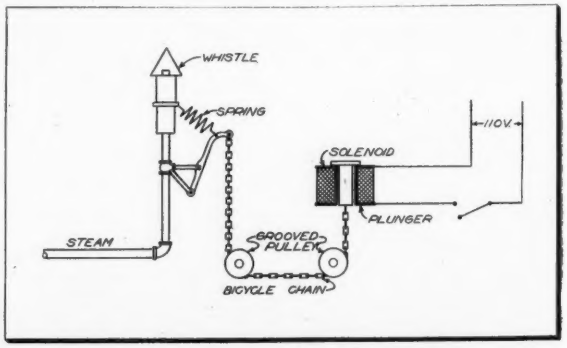
With the completion of the remaining engine divisions, it is proposed to take advantage of the possibilities afforded by the introduction of the electric locomotive by combining the present 4 steam engine divisions into 2 locomotive divisions of approximately 220 mi. length, changing crews, however, at the present division points. As the electric locomotive needs inspection only after a run of approximately 2000 miles, requires no stops for taking on coal or water, or layover due to dumping ashes, cleaning boilers or petty roundhouse repairs, it is expected that the greater flexibility of the locomotive so provided will result in considerable change in the method of handling trains now limited by the restrictions of the steam engine.

# Magnet Operated Whistle

THE ENGINEER BLOWS IT WITHOUT LEAVING HIS DESK

ILLUSTRATED herewith is a scheme of engine room signaling employed in the power plant of the Springfield (Ill.) Light, Heat & Power Co. and described in the Electrical World.

Connected to the whistle valve is an old bicycle chain attached as seen to a solenoid plunger. This solenoid is supplied with direct current at a potential of 110 volts and controlled by a switch on the operating engineer's desk. Closing the switch energizes the coil of the solenoid, creating an upward pull, which is in turn transmitted through the chain to the whistle valve, opening it and allowing the whistle to blow. A spring is provided, as shown, to shut off the steam as soon as the current is cut off from the solenoid.




SOLENOID-OPERATED ENGINE-ROOM SIGNAL

# Iron Pipe Lined with Portland Cement

THIS GIVES LONGER LIFE. METHOD OF PUTTING IN THE LINING. BY N. J. WILCOX

IT has been well established that wrought iron pipes which have been given a relatively thin lining of Portland cement mortar have practically indefinite lives, particularly when set in concrete, because the cement casings almost eliminate the possibility of corrosion. It is for this reason that wrought iron pipes that are used for water service and for conduits for electrical conductors are frequently served with cement linings where great permanency is essential.

In New England and in certain other localities in the United States, cement lined wrought iron service pipes have been rather extensively used, because the cement effectively protects the interior of the pipe, and prevents rusting and the clogging of the pipe due to accumulation of rust. Most of the municipal water works and the water works companies in New England line their own pipe. In Boston, and possibly in other cities, concerns have been organized that line wrought iron pipe for the trade, and due to their carefully designed equipment and relatively large outputs can market their product for less money than the individual can make it for himself.

Another possibility of the cement lining is that pipes of thin metal, even tin down spouting, can be made into satisfactory conduits if they are given cement linings. A great deal of cement-lined iron conduit was used possibly 10 or 12 yr. ago; but it became unpopular, probably for the reason that short circuits in these pipes frequently caused the cement to break away from the metal lining, and thus block the conduit. It may prove extremely valuable, however, in spite of this one disadvantage, for electrical construction men to know how to line pipes with cement, and the methods of doing it will be described in the following paragraphs.

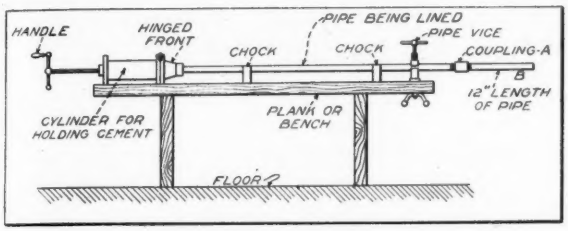



FIG. 1. APPARATUS FOR FILLING PIPE WITH CEMENT

Figure 1 shows the general arrangement of a lining outfit. A cylinder or screw piston press about 6 in. in diameter and 20 in. long is mounted on one end of a substantially constructed bench, and is used for forcing the cement mortar into the pipe. The head end of the press is so hinged that it can be swung open. The orifice in the head end is threaded for 2-in. pipe, but any smaller size can be accommodated by bushing down this hole. To use the apparatus, the cylinder is disengaged from the hinged front, then filled with cement mortar and clamped to the hinged front with suitable bolts. The length of pipe that is to be lined with cement is now screwed into this orifice in the front of the press,

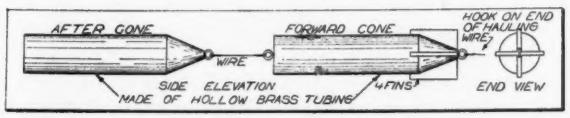



FIG. 2. MANDRELS FOR FORMING CEMENT COATING

and turning the handle of the screw plunger at the rear end of the press forces the cement from the press and out into the pipe. After the pipe has been filled it is unscrewed, shoved ahead, and clamped in the pipe vise at the further end of the bench. A coupling, A, is turned on the end of the pipe, and a spare piece of pipe about 1 ft. long is screwed into the coupling as far as it will go, the coupling being filled with cement, and the 12-in. length of pipe, B, used to protect the threads of the coupling from becoming filled with cement.

To form the hole through the cement in the pipe, a round rod is pushed through the cement from one end of the pipe to the other, having attached to one end a pair of metal mandrels, Fig. 2, each being a piece of brass pipe with its forward end a cone-shaped point. These mandrels are pulled through the pipe with the rod, and mold the bore through the pipe. A link of wire connects the 2 mandrels, which are of the same outside diameter that determines the thickness of the coating of cement. If a ⅜-in. cement coating is desired inside of the pipe, the mandrels should be ¾ in. smaller in diameter than the internal diameter of the pipe that is being lined. If a ¼-in. coating is desired, there should be ½ in. difference in the diameters. It is understood that in certain cases where the operators have become skilled in the manipulation of the device, coatings ⅛ in. in thickness have been successfully applied to the interiors of small iron pipes.

Four guiding vanes, or fins, which just fit within the unlined pipe, are arranged on the forward end of the first cone, and center it in the pipe as it is drawn through. After the cement has been molded by drawing the cones through, the pipe is set to one side so that the lining can harden, the length of pipe, B, being first removed.

# The Automatic Reclosing Circuit Breaker*

THEORY AND METHOD OF OPERATION; FIELD OF APPLICATION. BY E. C. RANEY

IN the application of protective apparatus to the power circuits of modern industrial plants there are 4 conditions which should be fulfilled: (1) The current must be quickly interrupted in case of short circuit or excessive overload, (2) The circuit should not be closed while the short circuit still exists, (3) To avoid unnecessary delay the circuit should be closed instantly upon the removal of short circuit, and, (4) For the protection of motors on the circuit, power should not be restored until controllers or starting box levers have been moved to the "starting position."

The first of the above conditions may be met by placing either a fuse or hand-operated circuit breaker in the circuit to be protected.

It will readily be appreciated that conditions (2), (3) and (4) are difficult to meet by either the hand-operated breaker or the fuse, in cases where the line is of considerable length and the load not in sight of the attendant.

Several years ago there was no protective device on the market which met all 4 of the above conditions, and it was the necessity for such a device which led the writer into the work of its development. The automatic reclosing circuit breaker or circuit controller described in this article is the result of these efforts up to the present time.

## THEORY

IN ORDER to make a circuit breaker which will automatically reset itself after the overload condition has been removed, it is required that a shunt circuit be provided around the main contacts, so that after the main contacts are open there may still be a small amount of current flow to act as an index to the condition of the line. The reclosing mechanism must be responsive to variation in this index current, which variation must be caused by the increase of resistance of the load or short circuit. For example, take the case of the circuit breaker placed on a 250-v. circuit, and set at 500 amp.;

*From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers.

when the load resistance becomes such that more than 500 amp. will flow, this resistance will be $R = E \div I = 250 \div 500 = 0.5$ ohm or less.

In case of a short circuit the resistance of the load becomes practically zero. It is evident that the breaker must be so constructed that it will not reclose while the load resistance is less than 0.5 ohm, and since in practical circuits it is always permissible to have lights, or a constant load connected to circuit, the breaker should be capable of reclosing whenever the load resistance has reached a value slightly above that which caused the breaker to open. Assume that in the above example the constant load is 50 amp. and the motor load 250 amp. The load resistance will then never be greater than 1 ohm, requiring that the breaker will not close on a load resistance of less than 0.5 ohm, but will reclose before the resistance has been increased to 1 ohm. In other words the reclosing mechanism must be sensitive enough to respond to a change of resistance of less than 0.5 ohm in the load circuit.

It is the ability of the breaker described in this article to respond to this slight variation of load resistance that makes it a practical piece of apparatus. A number of experimenters designed reclosing breakers prior to this, but they all lacked the essential element of being able to respond to slight changes of load resistance.

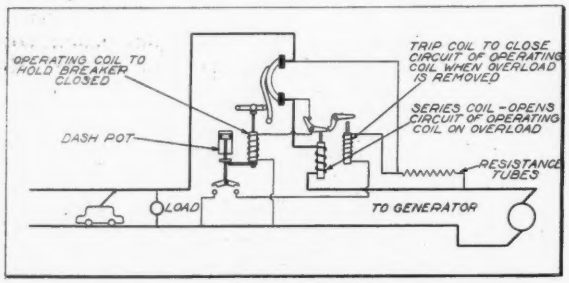

OPERATING COIL TO HOLD BREAKER CLOSED
TRIP COIL TO CLOSE CIRCUIT OF OPERATING COIL WHEN OVERLOAD IS REMOVED
SERIES COIL - OPENS CIRCUIT OF OPERATING COIL ON OVERLOAD
DASH POT
RESISTANCE TUBES
LOAD
TO GENERATOR

DIAGRAM OF CONNECTIONS OF AUTOMATIC RECLOSING CIRCUIT BREAKER

The resistance of the shunt circuit around the breaker must be 125 ohms, if we allow 2 amp. to flow at 250 v. on short circuit as an index current. In commercial circuits the voltage variation is liable to be 10 per cent or more, which means that the current variation through the 125-ohm shunt may be 10 per cent of 2, or 0.2 amp., due to that cause alone. The variation of current in the shunt circuit resistance, caused by the load resistance being increased from 0 to 1 ohm, will be $2 - 250 \div 126 = 2 - 1.904 = 0.096$ amp., which is less than the variation due to permissible voltage variation. It was the above consideration which led to the adoption of the shunt circuit used in the present breaker, where 2 paths are provided for the current after passing through the shunt resistance. One of these circuits is through a low resistance coil and the other through the load. In a branch circuit carrying a definite amount of current, the current divides in the 2 branches inversely proportional to their respective resistances. When the load resistance is 0 ohms on account of a short circuit, practically all of the current flowing through the shunt resistance passes through the load circuit; but when the short circuit is removed and the load resistance increased to 1 ohm, the current will be equally divided in the 2 branches and the current variation in the coil will be from 0 to 1 amp., which may be made enough to operate a relay setting the reclosing mechanism into operation.

### Operation

Referring to the diagram, it will be seen that the main contact brush is moved to closed position and held closed by the operating coil. The main load current passes through a series coil and main contacts. In case of an overload current in the series coil, its armature or core is raised and opens a contact which breaks the circuit of the operating magnet and allows the breaker to open.

The contact arm controlling the current in the operating coil is now held open by a latch until the trip coil operates to release the latch. After the opening of the main contact a small current is permitted to flow around the breaker through a high resistance. This current has 2 paths provided leading to the line of opposite polarity. One path is around the breaker and through the load, and the other through the trip coil and the dashpot bridge. So long as there is a short circuit, or low resistance on the load circuit, this index current will be shunted past the trip coil, but whenever the short circuit is removed or the load resistance increased to a certain amount, enough current will be forced through the trip coil to operate the latch and allow the contact arm to close the circuit of the operating coil again. The breaker is then instantly closed by this action.

A dashpot is provided to prevent the breaker from closing instantly after being opened by a momentary overload, the object being to give sufficient time for motors to come to rest and starting-box levers to be moved to starting position.

### Field of Application

Probably the greatest field of usefulness of this apparatus is in the protection of direct-current circuits of mines, mills, and elevator service.

At present there is a marked tendency for mine operators to purchase their power from a power company rather than to maintain a small isolated plant. The power purchased is in most cases a high-potential alternating current, which is transformed to a direct current of suitable potential by means of either a rotary converter or a motor-generator set. Short circuits and overloads are of such frequent occurrence in mines that, unless automatic means are used for restoring the circuit breaker, an attendant must be kept at such stations.

This form of apparatus is also ideal for the protection of branch circuits, since it affords individual protection to these circuits without interrupting the service on the entire system.

---

Mesta Machine Co., Pittsburgh, Pa., has recently acquired rights from the Stumpf Unaflow Engine Co., of Syracuse, N. Y., to build Stumpf Unaflow type engines in the United States, giving the Mesta Co. the use of the patent rights of Prof. Stumpf, and also the knowledge gained by 5 or 6 yr. experience building these engines by European manufacturers. Detailed shop drawings are now being designed for various sized rolling mill engines, also for large units to drive electric generators, air compressors and other machinery.

# Jeremiah Judson, C. E.

A Chalk Talk on Foundations

IT WAS noon again, and as usual when Jerry Judson, the trouble shooter, was in for a few brief days from a strenuous job on the road, after laying away the depleted collapsible dinner pail, he filled his Missouri meerschaum and wandered around the shop to see what had been done since he left, and sort of get a line on things in general, for possibly he might be called upon to erect some of the material lying around on the floor.

In the course of his wanderings, he came upon a crankshaft of an engine of possibly 400 hp., as the term goes. It had been returned to the shop without having been in operation, and he suspected that possibly a railroad wreck had sprung it, worse things than which have happened. But beside the old shaft on the floor lay a new one 3 ft. longer and a little different in design than was usual, inasmuch as the keyway for the belt wheel was as near the outboard bearing end as it was on the old shaft. Jerry paused and studied the situation, occasionally removing his pipe, blowing a wreath of smoke heavenward and watching the air currents waft it about. Then he sat down on a convenient bench and soon several more of the boys joined him in silence.

All began to study the new shaft, and finally Bert Ellis said: "I wonder what that shaft was sent back for and a new one made. That is for that job at Centralia, in the electric light plant, isn't it, Dutch?" addressing the one burdened with that Teutonic cognomen.

"Yah, dots der vone, und der shipping clerk says dot der bookkeeper told him dot der chief draftsman told him dot der Super told him dot der Old Man told him dot der faller at der plantz vere dot inchine vos going made a 'beef' ven he built de foundation und got der flywheel pit under der outpoard pearing dree feets too far avay from de rest of de inchine, und py golly ve haf to make a new shafts, und——"

"And Jones pays the freight and nothing said, as is usually the case," continued Jerry, breaking in on Dutchy's narrative for fear the belt would come off and he would run away. "Who built the foundation?" Jerry went on, looking around for the required information.

Dutch arose to the occasion. "Dos veis ich nicht, aber der shipping clerk said dot der bookkeeper——"

"Oh, short-circuit it, Dutch, and give us the other end of it," broke in Jerry.

"Der Superintendent off der lichtrich light plantz built der foundation und his fadder runs a grocery sthore und send his son to collidge und ven he gradiates from col——"

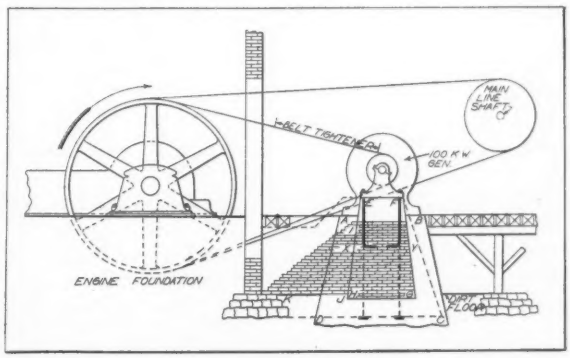
"That's enough," broke in Jerry," they can charge that up to experience, and profit and loss. Well, sir, that reminds me of the time,——" and Jerry began while the other six shut up.

"Oh, that was a good many years ago and I was a sort of an all round handy man with the I. J. Sacks Implement Co., over in Sackville, and the chief engineer was a good old scout named Jim Chapman. Jim was a capable man but, like some firms, the office thought that the superintendent ought to do lots of things that he knew nothing of just because he was superintendent.

"In the due course of things, it was necessary to install a larger generator to take care of the increased lights and some motors, so it was decided to buy a 100-kw. belted generator,—which was some generator for those days. As the line shaft was carrying all it could stand while the engine had a little to spare,—a very little,—it was decided to run the generator with a belt from the flywheel under the main belt to the line shaft.

"Right here let me digress a little. Several months previous to this, the firm took a notion to get a new superintendent, although the old one was to be kept as assistant, and, by the way, is still on the job as superintendent, while the many so-called young bloods who have tried their hand, passed on to the land of hasbeens.

"So, as is usual, they got a yellow haired bluffer whose name was Dahlston and whose shining characteristics consisted of an enormous gift of gab, no originality, an insatiable desire to change everything, and a memorandum book filled full of 'what they did down at Moville,' where his reign as superintendent was found to be very short also.




STEPS IN THE DEVELOPMENT OF THE FOUNDATION

"He insisted that he have full swing, so Chapman, with his years of mature experience, was sidetracked. As a sample of what he could do, to begin with, Dahlston had a 24 by 48-in. compressor built special and attached behind the 24 by 48-in. simple engine, extending the piston rod as required. This was to supply air for the oil burners, also of his own invention, used in the smith shop. As the engine speed was constant, being the main power unit, and the demand for air ranging all the way from 100 burners on down, the quantity of air compressed was also constant,—and the excess went out at the safety valve in a steady roar. Perfectly good money.

"But, to get back to what Dahlston did to the new generator. In front of the engine was the old grinding room, with a filled-in dirt floor; this was the location of the new generator. It was located so that when the engine room floor was extended, the generator would be on a level with it and the driven pulley just inside the main belt so that the generator belt would be on the inside, like this sketch."

(Here Jerry took a string, a strip of light wood and a piece of soapstone, and on the side of a piece of jacket iron sketched the accompanying illustration as he went on, giving a really intelligent chalk talk.)

"Dahlston started out all right," began Jerry again, after making most of the sketch, "by making a massive solid concrete pedestal about 12 ft. high to support the generator, going down through the filled-in ground to hardpan, as shown by the heavy lines, A, B, C, D. That was all right; but, as the belt was 26 in. wide, the driven pulley was supported by a heavy pedestal bearing on each side of it, while the generator of course had the customary 2 bearings.

"There was a heavy flange coupling between the pulley and the generator with a 'dutchman' so that, if necessary, the coupling could be unbolted and allowed to run as an idler in case it was necessary to repair the dynamo.

"Then Dahlston started in to mix things up. He scraped away a little of the top dirt on the floor and built up a light foundation of common brick and more common lime mortar, as shown at E, F, G, and H. The anchor bolts to hold the pedestals were of ⅝-in. round iron extending down into the little brick 'chimneys' about 3 ft. and bent over at the lower ends, as shown by the solid lines. The generator and the pedestal were put in place, leveled, squared, and made shipshape to receive the belt; but the flange coupling was not coupled up. Dahlston thought this was a fine layout, so he sent to Chicago for the belt and the man to put it on, and on Sunday we arranged the new 26-in. belt on an axle so that it would feed in under the 24-in. main belt, as shown, Chapman handling the engine with a master hand without getting it on the 'middle.'

"We put the belt tightener on at the place shown and started to screw up on the rods by hand, when, happening to glance at the flange coupling, I saw the pulley half suddenly jump towards the engine, an inch or more. Investigation showed that the brick pedestals under the pulley bearings had cracked at the bottom of the anchors (at X-Y) and raised up at Y till you could put your hand in the space.

"Dahlston fussed a lot, but finally we got the belt out again and ran another week as usual, while Dahlston got a mason to build a sort of inclined brick brace towards the engine, as shown at I, J and K. Common mortar was used and the bricks set just on top of the ground, and Dahlston swore that this would hold it, for 'he did the same thing down at Moville,' and proved it by his memorandum book!

"However, when we again put on the belt the next Sunday, and were just starting to use the wrench on the tightener, the brick pedestals jumped up again and, using the apex of the new brick triangle addition as a 'heel,' pried the brick at the break (at the bottom of the light anchor bolts) away about half an inch, so that when we released the tightener, the top of the pedestals overlapped the bottom by that amount.

"By this time, the president of the I. J. Sacks Co. began to observe things and stood by with his shiny tile just as he had come from church, where he had no doubt squared matters for us that were working. He and Dahlston had quite a heated controversy and passed a few left-handed compliments while we all looked on as referees and bottle holders.

"Finally, the president took off his plug hat and, swinging it through the air, coming pretty close to a few posts and a barrel or two, told Dahlston what we had known all the time,—that his gab factory was larger than his brain box, and wound up with the trite remark. 'You get out of here and run the factory if you know how and let the chief engineer run the engine room.'

"Then, turning to Chapman, he discussed the matter a little farther as to best methods of procedure, finally leaving it all to him. So once more was the belt run off and rolled up out of the way.

"Then we tore down everything except the concrete pedestal for the generator, A, B, C, D, and excavated down to hardpan and clear back to the engine room wall. We used inch iron for anchor bolts and they were long enough to extend clear through the new foundation, as shown by the extension dotted lines. The bricks were plentiful, so we laid them in Portland cement clear back to the wall and up high enough to support the floor joists, the new pedestal foundation being shown by the dotted lines. When this scheme had been carried out, we let it dry for 3 weeks and then set the pedestals on it.

"The following Sunday, the belt man again came up and, for the third time, we threaded that big belt under the other one. We put on the tightener and began to draw up; but when we had the belt as tight as a fiddle string, a straight edge on the flanges of the coupling failed to show a deviation of even a thousandth of an inch. So the belt was glued and next day was running.

"About a year ago, I happened to be near that part of the country and strolled in to see the old places and faces, and found that our job was still on deck, running every day, and that Chapman was still chief engineer. Where was Dahlston? Well, naturally I inquired, and was told that a year ago he was a clerk in a foundry at Madison.

"So you see, boys, it doesn't always pay to let the superintendent run things around the engine room just because he is superintendent, because he is liable to put his foot in something and the engineer has to put up with the inconvenience on one hand while Jones pays the freight on the other, as is the case with that new shaft for Centralia. But there goes the whistle," and soon the merry comments were drowned by the jingle of metal on metal.

---

IT IS FREQUENTLY advisable to go into debt for machinery, but the man who goes into debt should also be a good manager. Otherwise he had better stay away.

PROPER SANITATION is just as important in the power plant as it is in a hotel. It is absolutely essential to the best health of workmen.

A PAINT recently brought out in Europe is red at ordinary temperatures, but when heated, turns black, says F. J. Rankin, of the Colorado Agricultural College. After it has been allowed to cool, its normal color returns again. When this paint is applied to the iron work surrounding bearings, it is a visual indicator of the running condition of the machine. There are many possible applications in a variety of industries where this means of indicating a change in temperature would be valuable. It is claimed for this paint that the color will always follow the temperature, no matter how many times the cycle is repeated.

# The Decomposition of Ammonia

Its Causes; Some Preventives. By A. G. Solomon

WHEREVER ammonia is used as a refrigerant, there is a constant leakage occurring. By constant attention, leaks can be found and repaired and the plant kept almost perfectly tight.

Loss from the decomposition of the ammonia, commonly called burning, is a harder problem. This deterioration goes on slowly but surely and results from several causes. Excessive high discharge temperature quickens the process. If the ammonia were perfectly pure, any temperature reached in the daily operation of an ice machine would not affect it. Chemists state that a temperature of 900 deg. F. must be reached before pure ammonia decomposes.

The operating engineer has an entirely different proposition to handle. The ammonia he charges into the system is, most likely, pure and clean when it leaves the drum; but as soon as it enters the system, it becomes mixed with all kinds of impurities. Oil is the leading factor in the contamination; while water or moisture, air and particles of iron scale are also present.

Oil must be used to lubricate cylinders, valves and piston rods, and even with the best equipment and greatest care, some of the oil finds its way into every part of the system. Oil traps and separators are used, but the oil is so finely atomized that some of it passes to the condenser, where it sticks to the inside surfaces of the pipe when cooled. From the condenser, particles of oil pass on and finally lodge in the evaporator coils. Some of the oil takes the form of gas when leaving the compressor at a high temperature and passes entirely through the system again and again until finally blown out through the purge valve, together with the noncondensible or permanent gases.

Water or moisture is also ever present in the system. It seems impossible for such to be the case, but it can be easily seen how such a thing can happen. All systems are pumped down below atmospheric pressure at some time and then brine or the moisture from direct expansion coils will be drawn in through leaks so small as not to allow ammonia to escape, and yet to allow moisture and air to enter whenever the pressure is reduced below atmospheric. This is explained by the presence of oil and particles of scale on the inside pipe surfaces. This oil and dirt will lodge in the minute leaks and entirely stop them while the pressure is greater on the inside than on the outside of the pipe. When a vacuum is pumped, these small leaks are opened as the atmospheric pressure forces the plug of oil away from the leak. Air that is drawn in will travel through the system till blown out as permanent gas.

Water which enters the system in the form of brine or moisture is harder to deal with than air, as it will lodge in the cold coils and stay there, taking the life out of the ammonia and giving up a noncondensible gas. At a temperature corresponding to the usual pressure in the evaporating coils, water will take up about an equal weight of ammonia. This ammonia that is so taken up will give off more permanent gas to be circulated through the system.

Moisture is often drawn into the ammonia compressor on the piston rod. This more often happens on the double-acting humid gas machines which are often operated with frost on the stuffing box and the rod so cold that it sometimes frosts.

When running on very cold temperatures requiring a back pressure of atmospheric pressure or even below, the moisture on the rod is drawn in in large quantities. Sometimes, on opening up a cylinder which has operated on these conditions, drops of moisture will be found clinging to the inner surfaces and also water will be found in such places as the valve chambers and the hollow parts of the valves. When a mechanically driven pump is used to supply oil to the rod packing, it is often noticed that the pan from which this pump draws the oil is directly under the stuffing box, which is continually either frosted or at least sweating. The water is always dripping into the oil pan and being pumped back on the rod. This manner of getting water into the system can be prevented and should receive prompt attention.

During the winter's overhauling, moisture is often left in the coils that have been steamed out to remove the oil. To clean the coils in an ice or brine tank, each coil should be blown out separately with steam and air. The brine must be first removed and the coils disconnected from the upper and lower headers. The steam is first allowed to blow through the coil till all oil and dirt is removed and then, while the coil is still hot, air must be blown through to remove the moisture. This must be done thoroughly, but even at the best some moisture will remain.

Some engineers take a lot of additional trouble to remove this moisture, and I believe they are repaid during the season. After the coils have all been steamed and blown out with air, they are connected up and tested with air pressure. After all leaks are tight, the tank is filled with brine or water, steam is turned in and the temperature is kept at a high point (180 to 200 deg. F.) for about 48 hr. Openings must be made at the top header or other suitable place to allow the escape of the vapor, which will be caused by the hot brine around the coils.

Another way of cleaning the coils is to have the tank full of brine and heat it and leave the drains open on the bottom headers. As the oil becomes heated, it will flow out, and to finish the job, air must be pumped through the coils to force out all the oil. The air in such a case will leave no moisture as the temperature of the brine will keep it from condensing.

Rooms with direct expansion piping can be cleaned in the same way with little danger of future harm to the ammonia on account of the moisture.

In charging ammonia into a system, there is no need to pump a vacuum on the drums as some engineers do. The charging connection should be into the evaporating coils and a drum can be connected up and opened and left till empty. Even if 15 or 20 lb. back pressure is left in the drum, there is no liquid ammonia present, only a light gas.

When a leak is found which requires the transferring of the ammonia from one part of the system to another, the part where the leak is located should not be pumped below atmospheric pressure or air or brine will be drawn in. To sum up this part of the operation of the plant, just remember: Don't pump a vacuum unless there is a connection so that the compressor can be made to discharge into the atmosphere while pumping on a part of the system where there is a leak. Don't pump a vacuum at any time unless it is absolutely necessary. Always after pumping the system down low, the oil trap on the discharge line should be emptied.

Sometimes the owner or manager of a plant will object to the drawing off of this water and will claim that it contains too much ammonia. It is true that there is a lot of good ammonia in it, but I claim that anything that will settle in the bottom of a discharge gas receiver or oil trap has no business in the system. Of course, an ammonia regenerator or purifier can be used and really should be installed in all plants. This regenerator can be connected in such a way that ammonia, oil and moisture can be taken from any part of the system and purified, insuring pure ammonia and preventing any loss due to drawing off of ammonia with the oil and other substances.

Mixing different brands of ammonia has also been known to cause rapid deterioration. The reason for this seems hard of explanation, as pure dry ammonia should not lose any of its purity by being mixed with another brand of equal reputation; but all ammonia is not made in just the same way, although the source from which it is obtained is the same. Different processes of manufacturing and purificating will cause some small differences in the finished product. A chemical action can set up and cause decomposition; that is to say, the impurities in one brand will act in union with the impurities in the other and by this union cause decomposition which would not result if either brand were used alone.

Ammonia coming in contact with 2 or more different metals used in the construction of the plant sometimes causes galvanic action which will help in the accumulation of permanent gases.

Now we have to deal with so-called burning of the ammonia. On dry gas compressors, especially, the temperature of the discharge is rather high, at times reaching 300 deg. F. or more. The gas, heated to such a temperature and coming in contact with foreign matter such as oil, permanent gas or moisture, will decompose rapidly. A temperature of over 200 deg. F. should be avoided for at least 2 reasons. The ammonia burns up at higher temperatures; and the ammonia condenser efficiency is reduced. At 265 deg. F., ammonia is at its critical temperature, at which it will not condense. At this temperature, it acts like a perfect gas and must be cooled before it becomes condensible.

To sum up the subject, remember to: Avoid pumping any part of the system below atmospheric pressure. Purge the condensers whenever any permanent gas is thought to be in the system. Keep oil traps and low points of the system drained. Keep discharge temperature at or below 200 deg. F. Keep full charge of ammonia in the system at all times. Clean the whole system thoroughly every winter. Install ammonia purifier or regenerator and work it continuously.

# Setting Expansion Valves

EXPERIENCES WHICH HAVE PROVEN VALUABLE IN THE OPERATION OF A REFRIGERATION PLANT. BY T. G. THURSTON

EXPANSION valves are generally the cause of more grief to the beginner in refrigeration than all the rest of the system put together. Either he will not open them enough and the machine will run hot, the packing will be smoking in the stuffing box before he is aware of it, and he will most likely open up too much again in order to get things back to normal, and the first thing he knows, the machine is ice cold and the stuffing box leaking in good shape so that he can hardly get close enough to it to tighten it up; or, he may get them set so that the machine is working nicely and find to his surprise that the temperatures are going up at an alarming rate and he will be more puzzled than ever.

I can remember my first experience in handling the expansion valves. It was a small machine working on a direct expansion system in a number of freezers. It nearly drove me wild; I kept trotting between the freezers and the engine room all day. The machine started to get a little too cold to begin with, so I went up to the freezers and shut off the expansion valves a little; when I came back to the engine room the head pressure was nearly up to where the relief valves would blow and the machine was colder than ever. In my anxiety to get the head pressure down, I hurried back to the freezers and opened a few of the expansion valves quite a little. When I came back to the engine room, I found the head pressure down and the machine warming up. It was not long before the machine was running too warm, so back I went to the freezers and opened the valves a little more. This made matters worse, so I had to repeat the performance. This happened several times during the day. On top of that, the temperatures went considerably above normal and the night engineer sarcastically remarked that somebody must have put stoves in the freezers.

In setting the expansion valves, there are 2 factors to be considered—the expansion coils and the machine. The refrigerating capacity of an expansion coil depends on what proportion of the coil is in contact with liquid ammonia and the pressure in the coil. To secure maximum capacity from the coil, the liquid should be supplied at a rate sufficient to keep the coil full; if some escaped into the suction line it would make no material difference and the pressure should be a vacuum.

With the machine, the reverse is the case; liquid in the returning suction gas will wreck the machine sooner or later and if there was an absolute vacuum in the coils, the capacity of the machine would be zero. The capacity of an ammonia compressor varies approximately as the absolute back pressure; hence, to get maximum capacity from the compressor, the back pressure should be as high as possible; if the back pressure goes above a certain point, the expansion coil stops working, this point depending on the temperature outside of the coil; this is determined by the temperature of the rooms or brine in the brine tank or cooler.

Obviously, then, the back pressure must be low enough so that the ammonia will evaporate at a suffi-

cient rate to maintain the desired temperature of the rooms or brine and the expansion valves adjusted so that the coils are full of liquid ammonia, but so that none escapes into the suction line. This is the puzzle. I doubt whether one of every hundred plants even approaches this ideal condition.

The flooded system is an exception. With this system it is possible to keep the expansion coils full, the excess goes over into an accumulator and back to the coil, and nothing but saturated gas goes back to the machine.

The problem for the operator, then, is to adjust the expansion valves so that the coils will be full of liquid and no more and no less. This is quite simple if there is only one valve on the system, as for instance, where a brine cooler is used with thermometers in the suction and discharge lines of the compressor. The expansion valve is opened up until the thermometer in the suction line shows a temperature 1 or 2 deg. higher than that corresponding to the back pressure. The machine will then be working to the best advantage.

When the valves and coils are multiplied, the trouble begins. It then becomes a problem to determine what each coil is doing. This is a hard problem and is never thoroughly mastered until the operator is thoroughly familiar with the peculiarities of each individual expansion valve. An expansion valve is seldom opened more than from a quarter to half a turn. Now, a quarter of a turn on a valve with quite a little lost motion in it will only crack it off the seat. If the valve has no loose connections, it will open it quite a little.

Some makes of valves have a coarse thread on the valve stem and others have a fine thread. Obviously the thread with the greater pitch will open more for a given turn on the wheel than the one with the smaller pitch. The condition of the valve and seat also make a difference, as a scored seat and valve will let through more liquid than a good one with the same opening.

In most plants, the operator judges the working of the system by the temperature of the machine. Judging by this alone may be misleading, as may also the thermometer in the suction line if there is one. It is possible to get the proper indication on the thermometer or the proper temperature of the machine with only one coil working properly.

To illustrate: I can remember one case where we were running 3 machines together on 4 brine tanks. The frost began to come off the machines and they began to warm up, so I opened up a little on the expansion valves on the 2 nearest tanks which seemed to be a little short of ammonia. When I came back to the engine room, I was surprised to find the machines warming up at a still faster rate than before. The thermometer in the suction line on one of the machines showed a rise of 10 deg. over what it was when I went to open up on the valves. I hurried back and opened up a little more without results. I went back and opened up the valves quite a little more and found the suction temperature coming down, but I still had to open up a little more to get them just right.

The trouble in this case, as well as my first experience, was that some of the valves were open too much and some not enough. In the last case the valves on 2 of the tanks were open too much and not enough on the other 2. If I had shut entirely the 2 valves I had opened, the machine would have cooled down and the suction temperature would have been about right. Instead, when I opened up on the valves, the increased amount of superheated gas from these tanks more than offset the excess liquid in the gas coming back from the other 2 tanks.

In my first experience with the direct expansion machine, the valves were open only a very little and a little foreign matter in the liquid would clog them. This is what happened. When the valves clogged, the liquid naturally crowded through the rest of the valves that remained open and 1 or 2 of these most likely were open a little too much in the first place. When I shut the valves off still more, it aggravated matters, because this cut down the flow through all the valves, running up the head pressure and forcing a still larger proportion through the valve that was open widest. On the next trial I happened to open up the valves that were clogged. This reduced the head pressure and cut down the feed on the coils, causing the trouble, and the superheated gas from the coils I had just opened neutralized whatever excess was fed through the other coils.

It will now be readily understood that if all the coils but one were blocked up and the valve on this coil set just right, the temperature of the machine and the suction thermometer—if there is one—will be just right.

There is one indication, however, that will show this, and which I had overlooked in both cases just mentioned. This is the suction pressure. Any time that there is a reduction in the rate of evaporation, from any of the valves stopping up or changes in the head pressure varying the feed through the valves and to the coils, it will be indicated at once by a reduction in the suction pressure.

Another point I overlooked in the case of the brine tanks was the appearance of the suction valves at the end of the coils. On a brine tank or in a room where the temperature is above freezing this will give a pretty good idea of what the coil is doing; if the coil is working its whole length the suction valve will be well frosted. If the coil is only working part of its length the suction valve will be thawing off, or it may lose its frost altogether.

The suction pressure in connection with the frost on the machine or the temperature of the suction and discharge gas are the best indicators of the working of the system as a whole, but give no basis for judging the individual coils. This can be determined only by observation, study and experiment. The frost line on the expansion valves, the sound of the valves, the appearance of the coils themselves in direct-expansion work, the appearance of the suction valves and the temperature variation in the room, where the coils are in separate rooms, are all good indications of the working of the coils. If there is a sufficient charge of ammonia in the system there is a certain frost line on the expansion valves for a given rate of feed. If the valve partly clogs up, the frost line will crawl up on the valve in proportion to the decrease in the feed. If the valve stops up entirely, the whole valve will generally frost up.

The sound of the valves may vary from a hardly audible hiss to a singing, rasping, gurgling sound, de-

pending on the style of valve, its connection to the coils and the rate of feed. The coils themselves should, of course, be frosted their entire length if the coil is worked to its full capacity and the suction valve should be well frosted.

If the temperature of a room that has been holding or coming down begins crawling up without any additional stock having been put in the room, it is a pretty good sign that the expansion valve has partially or wholly stopped up and the valve should be readjusted.

If the valves are once set right and the temperature of the rooms or brine remains the same, the suction pressure and the temperature of the machine should remain the same. If, now, for instance, the suction pressure drops down a pound or two or even more, and the machine starts to warm up or freeze up, some of the valves are partly or all stopped up.

If in going over the system we now find 1 or 2 valves all frozen up, with the corresponding suction valve losing its frost, and if it is a direct expansion coil, the coil itself thawing off and no sound in the expansion valve when we get to it, we know that here most likely is the cause of the whole trouble. Open the valve wide for a few moments and let the liquid rush through to fill up the coil again and clean the valve or valves. Generally the suction pressure and the temperature will be found to be back to normal when we get back to the engine room.

Care should be taken not to open expansion valves too wide. This can be done when the system is short of ammonia, a large amount of gas blowing through with the liquid. In this case, the frost will disappear from the expansion valve, and if the valves are opened still more the expansion valves, liquid header and sometimes the liquid line for some distance back will frost over. The obvious remedy is to charge more ammonia into the system; but if this cannot be done, the valves should be closed enough to take the frost off the liquid header and the high-pressure side of the valves.

One point to remember in setting the expansion valves is the position of the valves on the header or liquid line. The valves at the end of a header or liquid line will feed at a greater rate, for the same opening of the valve, than those in the center or along the line.

An illustration may better explain this. In a certain installation I have in mind, there are 12 valves branching off from a main header. The liquid line connects to the center of the header. In normal operation, the 2 valves on each end of the header are opened only about 1/6 of a turn, the valves next to these about 1/5, the next about ¼ turn and so on, so that the valves at the center of the header are open ½ turn. With this setting, there is maximum back pressure with the proper temperature of the machine and the suction valves on all the coils are all frosted up evenly.

Another instance I can remember was where there were 3 valves at the end of a long liquid line ending in a cross; a branch to each side supplied 2 coils and the other outlet of the cross, in line with the main liquid line, supplied the third coil. This third coil was larger than the other 2 and in a room several degrees warmer. The expansion valves were all of the same size and make. In regular operation, we could not open this third valve much more than 1/3 as much as the other 2 or it would flood the coil and freeze up the machine, because the momentum of the moving liquid and the fact that the valves nearest the liquid line get most of the gas, if any, carried along with the liquid.

To get the highest efficiency of the system, carry the highest back pressure possible with the proper temperature of the machine. To determine this, experiment with the expansion valves, noticing the effect on the suction pressure and temperature of each individual valve. When the proper point is found for the existing conditions, the suction pressure and the suction and discharge temperature or the frost on the machine will indicate any defective working of the coils.

---

# Horsepower to Pump Water

PRACTICAL REFERENCE TABLES FOR 1 TO 350 FT. AT 100 AND AT 55 PER CENT EFFICIENCY. BY H. M. NICHOLS

PRACTICAL ENGINEER Reference Tables in this issue give the horsepower required to pump water with a pump efficiency of 55 per cent, and also the theoretical horsepower required if it were possible to have a pump efficiency of 100 per cent.

The 55 per cent pump efficiency is taken as being a fair average of commercial pumps, and will be found accurate enough in most cases for estimating the power that will be required to drive the pump.

Pump efficiencies vary through a wide range, and it is difficult to give a general rule for estimating the efficiency of a particular pump, as it depends on the type, head, capacity, and make.

Centrifugal pumps vary in efficiency from around 30 per cent to a maximum of nearly 80 per cent. Pumps having a plain discharge casing show the lowest efficiency; next come pumps having volute or scroll casings, while the most efficient type employ diffusing vanes in the discharge casing. These diffusing vanes increase the efficiency by taking the water as it leaves the pump impeller with a high velocity and converting a portion of the velocity energy into pressure energy.

For high pressures, multi-stage centrifugal pumps are more efficient than single stage pumps.

Centrifugal pumps which are not provided with diffusing vanes rarely exceed 50 per cent in efficiency, and centrifugal pumps which are required to work under a suction head are not as efficient as they would be if working against pressure head alone. It is also an interesting fact that when a centrifugal pump is used as a booster so that there is a certain pressure on the pump inlet, there will be an increase in the pump efficiency. This seems to be due to the prevention of cavitation around the pump impeller.

In all cases of pumps working against suction, it is necessary to add the suction head to the pressure head to obtain the total head against which the pump is working.

In cases where the pump efficiency is known to differ from 55 per cent, to find the power required to drive the pump, it is necessary to divide the theoretical horsepower, given in the table, by the efficiency of the pump. For example: If a motor-driven pump has an efficiency of 60 per cent, pumping 1000 gal. of water per minute against a total head of 120 lb. per sq. in., then from the

table the theoretical horsepower required would be $7.0 \times 10 = 70$. The actual horsepower required to drive the pump would be $70 \div 0.60 = 116.6$.

The table can also be used for finding the horsepower obtained from water wheels. In this case, to find the actual power delivered by the wheel, multiply the theoretical power, corresponding to the given head and flow, by the efficiency of the waterwheel.

Where the horsepower required to drive a pump is known, and it is desired to find the efficiency of the pump, look up the theoretical horsepower in the table, corresponding to the head against which the pump was working, multiply this value by the number of gallons discharged per minute; divide by the actual horsepower which the pump took under test, and the result will be the efficiency expressed in per cent.

Assume that a pump takes 50 hp. to deliver 500 gal. per min. against a total head of 100 lb. Then, Efficiency $= 5.833 \times 500 \div 50 = 58.33$ per cent. In measuring the power taken by pumps under test, allowance must be made for losses in the driver. For example, if the efficiency of the motor driving the pump mentioned above was 80 per cent, then the power measured at the motor terminals would be $50 \div 0.80 = 62.5$ hp.

Steam driven pumps rarely utilize over 50 per cent of the indicated horsepower, but low efficiency is not so serious a drawback in plants where the exhaust steam is utilized for feed-water heating or other purposes.

# It Happened in West Virginia

EXCITEMENT IN A BOILER INSPECTION. BY N. DEVERING

HALT, there! feller, Hands up! Put 'em up. Consarn you. Put 'em up, an' no foolin'!"

I faced about and gazed into the end of a long rifle, held by a lank individual, quite serious and savage looking, with a nickel plated star pinned on the breast of his coat.

"What's the matter with you?" I demanded.

"Nothin', young man; nothin' wrong with me. But there soon will be with you, I'm thinkin', when I get you down to Squire Hodges. We'll see if we can't stop some of these here robberies goin' on here these nights, when good folks is in bed."

It was 3 o'clock in the morning, I was on my way from the hotel, at one end of the village, to the large lumber mill at the other end, where I was to inspect the steam boilers and get away on the morning train, as there was no other until evening. And now I discovered that I had been taken for the robber who had been busy plying his profession in the village during the past month.

"Young man, you jest hold on to that bag you have with one hand, an' keep the other up in the air or you'll be sorry fer it. Jes' face about an' I'll march you over to the Squire's office."

"What's the matter with you? I'm a boiler inspector on my way to the mill to inspect their steam boilers."

"Thet's a likely 'nuff story, young feller, but it won't go this time. Jes' keep movin' along."

I was marched up to Squire Hodges' door, the Honorable Squire was routed out, and informed in loud tones of the capture made by the brave town constable, also all near neighbors got the startling news by way of bedroom windows.

After being marched into the livery stable office, which served as the Squire's court, being surrounded by a half dozen near residents, I was searched; no firearms being found on me, I was given a seat.

Then spoke the squire: "Young feller, what might be your name?"

"Albert N. Moore. I'm a boiler inspector."

"You're a boiler inspector, eh! Well, Mr. Moore, there hez bin considerable stealin' goin' on round here lately, an' we'll hev to investigate you a little, sence our High Constable found you on the road so early in the morning. Constable Nujane, will you open this feller's grip, 'til we see what he carried round so early in the day?"

Thereupon the energetic officer proceeded to open my grip and remove the contents, first picking up my hammer, he remarked:

"Your Honor, here is a hammer, an' one side of it is flat an' sharp, so it might be handy fer pryin' open a winder or shutter. Do you see it, fellers?" (holding the hammer up in view of all onlookers). And the grunt of approval went around.

"An', by gum, he hez an extry pair of shoes in here; an' a suit of clothes here that his ole granny wouldn't know him in.

"An', Squire, look a yer," holding up my inspector's torch, "ef he hain't got a lamp yer; a long, round, brass one, you could stick it in the bung hole of a cider barrel.

"An' here, what in thunder is this contrapshun," handing the gage test pump to the Squire. Then the Squire, holding the test pump gingerly: "Now, speak up, young feller, an' tell the whole truth. Is this one o' them pumps used fer pumpin' explosives in the locks of safes?"

"That is a test pump, your Honor, used for testing steam gages."

"Well, it might be, fer all I know, but it's a mighty superstitious lookin' article, an' I reckon we'll hold it fer further examination."

The high constable continued laying out the various tools, gages, etc., expressing his valuable opinion of each article, while the natives continued to look me over and pass remarks as to what should be done with me, and what the penalty should be for the numerous robberies that had been committed.

The constable next found a pint jar of carbide, which was used in the torch when making internal inspections. He unscrewed the cap and placed the jar to his nose; jerking it away quickly, he exclaimed: "Jedge! Here's some new fangled dol-garned explosive or somethin'! The crowd backed towards the door with frightened faces.

The Squire took the jar and smelled the carbide, then holding it at arm's length and looking around the room, his gaze fell on a bucket of water near me. "Here!" he cried, "put the dinged stuff in that bucket of water; that'll put it out o' bizness, I guess."

The constable took the open jar of carbide very carefully, carried it over and pushed it down into the water. Immediately the water began to bubble fiercely as the gas came to the surface and began to pass off into the

air. Everybody looked startled, and then an idea struck me. I hurriedly pulled a cigar and match from my pockets, lit the cigar, and by this time considerable gas had escaped from the bucket. I threw the lighted match over the bucket—there was a flash of fire from the bucket to the ceiling—and helter-skelter, pell-mell, went the squire, the constable and all the onlookers, scrambling over each other, through the front door and back through the livery stable in every direction, none stopping until he was well away from the livery stable office.

Throwing a horse blanket over the bucket soon extinguished the blaze, and no damage was done except destroying my carbide.

About the time I had replaced my kit in the grip, the Squire and several followers looked in at the front window, and seeing all was well, came into the office. With them was one of the firemen from the mill, who was on his way to the hotel, to inquire why I had not come down to the mill to inspect the boilers.

This fireman explained to the Squire that I was the boiler inspector, and they wanted me down at the mill "right smart," and that I was no robber, for he had met me at the hotel the evening before.

So I shook hands with the Squire and his High Constable, completed the inspections at the mill, and caught my train by a close margin.

# Accident Relief and Service Pensions for Westinghouse Employes

BEGINNING Jan. 1, 1915, the Westinghouse Electric & Mfg. Co. has put into effect a plan for sickness and accident relief and service pensions, on which the officers have been working for more than a year. There are 3 features to the plan, first, extension of present relief work, second, an accident compensation fund, and third, service pensions.

The Relief Department is open to every employe, regardless of age, position or location, upon payment of small monthly dues. These dues are used entirely for the payment of benefits, the company bearing the entire expense of operation and maintenance of the department. If at any time there is a deficit in the relief fund, the company will make this good. The benefits are proportioned according to the wages, to give relief in case of sickness or accident arising from other cause than employment, and the benefits will continue as long as disability last or up to the age of 70 yr., when the pensions will be granted. In the event of death, the company will pay a benefit equal to the amount of dues which have been paid to the fund.

Accident compensation is maintained entirely by the company for the benefit of all employes, whether they belong to the Relief Department or not. The plan covers payment for disability due to accident, or for death resulting from accident while at work, and makes provision for both total and partial disability. In case of total disability, the company will pay, during the disability period, though that may be for life, ⅔ of the average wages received, and for partial disability, ⅔ of the reduction in the earning capacity of the employe, even though the employe may leave the service of the company. In case of death, the company will pay dependents or next of kin, $150 to cover funeral expenses, and will pay to dependents as a death benefit ⅔ of the year's salary, but not exceeding $780, and also an accident compensation pension, up to a maximum of $15 a week, of 30 per cent of wages to the widow and 10 per cent additional for the support of each child until it reaches the age of 16. If no widow is left, 15 per cent of the wages will be paid to the guardian for each child until it reaches the age of 16. If there are no dependents left, the death benefit will be paid to the next of kin, but no pension will be paid. Medical, surgical and hospital expenses, under the direction of the company's medical officers, will be paid during disability from such accidents.

Employes of the company are to be retired at the age of 70, and those who, at the time of such retirement, are members of the Relief Department and have completed at least 20 yr. of continuous service for the company, will have a pension amounting to one per cent of the average monthly wages during the last 10 yr. of employment for every year of continuous service, the minimum pension to be $20 a month, and the maximum $100 a month.

Upon death of the pensioner, ½ of the pension will be paid to the widow, provided the marriage took place at least 10 yr. before the granting of the pension, until remarriage. For the support of each child under 16 yr. of age, and for each wholly dependent grandchild under 16 yr. of age, ¼ of the pension will be paid until the child reaches the age of 16.

It is within the discretion of the president of the company to retire any employe between the age of 60 or 70 who has been in service the required time, and he may increase any pension for specially meritorious service by 25 per cent, if this does not bring it above the maximum of $100 a month.

In states which already have Workmen's Compensation Laws, such as New Jersey, Ohio and Illinois, these laws may be substituted in whole or in part for the accident compensation and service pension but if the provisions of the Westinghouse plan are the more liberal, these will generally be put in force.

---

FROM EXPERIENCE with tread mills in British prisons, we know accurately the mechanical equivalent of hard labor. It is a climb of 8640 ft. in 24 hr. If the average weight of a man is 150 lb. he can do approximately 1,200,000 ft.-lb. of work each 24 hr. A horsepower for 24 hr. is approximately 48,000,000 ft.-lb. It would require 40 men to develop a continuous horsepower, and their wages would be $80 per day, or $28,800 per year.

An electric motor to do the work of 40 men would consume not more than $180 worth of electricity per year. It is, therefore, obvious that men were never intended for use as generators of power. When you have a few machines to run, bear in mind that the electric motor will do as much work for you for one dollar as the best unskilled workman can do for $1500. The "silent servant" is never sick, never needs a vacation, and never asks unnecessary questions.—Farm Engineering.

# LETTERS DIRECT FROM THE PLANT

*Cash Paid For Ideas Accepted. Sketches Desirable.*
*We Make The Drawings*

## Economy for the Steam Laundry

THE STATEMENT of H. W. Sims, on page 1165, Dec. 1 issue, that the relation between the exhaust steam resulting in the development of sufficient power to operate the laundry and the heat units required in furnishing a sufficient quantity of hot water is that of practically a perfect balance, was clearly demonstrated to me a few years ago in a small plant of which I had charge.

In this plant, there were a closed and an open heater, the closed heater supplying water to feed the boiler; this water was heated to a temperature of about 190 deg. From the closed heater, the steam went to an open heater and then to the atmosphere. The water from the open heater was used for washing, and as the demand for it was intermittent, it was never very hot. There was an open tank supplied with a float that received the water from the heater, and when no water was being drawn from the tank, none flowed through the heater, in consequence of which the steam was thrown to the atmosphere without doing work. In order to furnish hot water to the washers, it was necessary to use live steam. This did not appeal to me, as I was fireman, engineer, electrician, machinist and master mechanic, so I set about seeing what could be done.

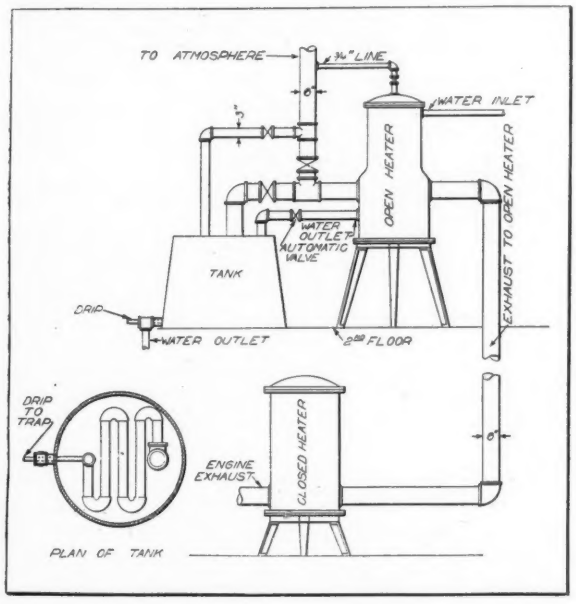



FIG. 1. METHOD OF KEEPING A SUPPLY OF HOT WATER IN A LAUNDRY

I finally submitted to the management the idea of putting a coil in the tank, as shown in Fig. 1. After this was done, we had water at 210 deg. and no exhaust steam was ever seen escaping from the exhaust pipe. The drip from the mangles and from the drain to the coil was trapped and put in the tank also. This resulted in a marked saving of coal and gave me more time to devote to my other labors.

In the plant where I am at present employed, which consists of 8 boilers, we have the same trouble of escaping steam from the auxiliaries and an inefficient heater. There is an old heater out in the junk yard that I wish to pipe up, as shown in Fig. 2. I am confident that I can reclaim a large amount of heat now going to waste. As it is impossible to get the company to install a new heater in place of the one we now have, the installation of the old one will answer the same purpose. The steam that escapes from one will be condensed in the other, adding at least 10 or 20 deg. of heat to the feed water.

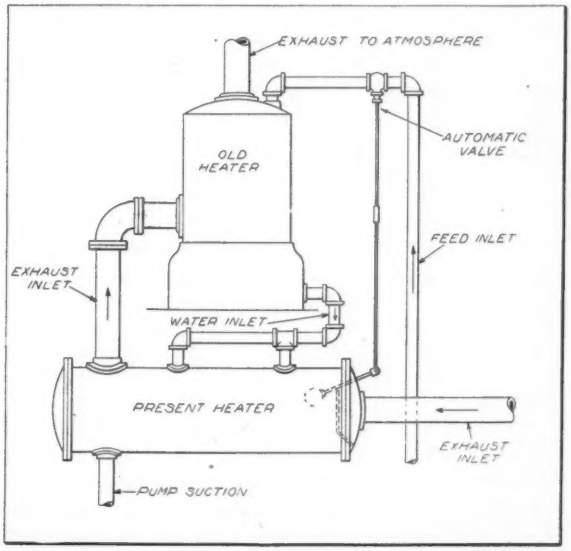



FIG. 2. METHOD PROPOSED FOR USING OLD HEATER

There is another peculiar condition at this plant. We have 7 250-hp. and 1 500-hp. Stirling boilers. The small boilers have a middle steam drum 54 in. diameter, while the 500-hp. has a steam drum 48 in. diameter. The boilers have flat grates. With the small boilers we can carry a steady water level, with only a slight variation during the time of cleaning fires or when the mill shuts down; but with the large boiler, which is the last one on the line (that is, farthest from the engine), when cleaning fires the water will drop from 2 gages down out of

sight in the glass. This, of course, causes the automatic feed valve to open and bring the water back to normal again, and when the fires have become cleaned and fired up again, the water will rise and blow out of the high water alarm. This same thing will happen when the mill shuts down and starts up. It has been the cause of burning 2 soft plugs in this boiler.

I have suggested that, as the steam drum is so much smaller, there is a greater tendency to raise the water in this boiler. The outlet to all our boilers is 8 in. and it seems to me that a larger outlet to the steam header, say 12 in., on this boiler, would reduce this trouble.

H. SKATON.

## Lap of Steam Valves on a Corliss Engine

JOSEPH STEWART'S letter in the Dec. 1 issue, page 1165, interested me, as I think the matter about which he writes is timely, and I do not remember having seen any discussion on the subject before.

He refers to the definition of lap as applied to the valves of a double eccentric Corliss engine. Differences of opinion exist, but when the case is analyzed, I don't think there will be much cause for difference of opinion in regard to the true state of affairs. Custom and convenience frequently sanction the use of terms and expressions that are not absolutely correct, but which convey the ideas intended better than in any other way. It is so with the term "lap" as applied to a double eccentric Corliss engine.

The original and correct definition of the term as used in connection with steam engine valves, considers the central position of the valve when measuring lap. Of course, it was first used in relation to the ordinary common D slide valve. Then, as other types of valves appeared, the term was applied to them if it was at all possible to do so. Now, the valve gear of the single eccentric is the same in principle as that of the common D valve and the same terms relatively may be used. For example, "lap" means the amount the edges of the steam valve overlap the steam edge of the ports when the wristplate is at the center of its travel, and with the valves hooked up in the latch. But, when the valves of a Corliss engine are "unhooked," they will still further lap the steam ports, as when the dashpots close them to the fullest extent. That is also true, however, in the case of the D valve, when it is at one end of its stroke; but no one has ventured to say that the amount of lap as so measured, is the lap as defined.

The 4 valves of a Corliss engine simply represent the 4 separate edges of a common D valve, 2 steam and 2 exhaust edges, but capable of distinct and independent adjustment, which is not quite true in the case of D valves. In the case of the single eccentric Corliss engine, there seems to be no doubt nor any misunderstanding as to the use and application of the term "lap."

With double eccentrics, there is doubt and misunderstanding, as evidenced in Mr. Stewart's letter. For reasons which I cannot enter into at present, the steam valves of a double eccentric Corliss engine have no lap, but give a certain amount of port opening with the wristplate central and the valves hooked up; this, as a matter of convenience in expression, is sometimes called negative lap. It conveys—or should convey—the exact idea. It is true, that when the valves are released and close the ports to the fullest extent, they lap a certain amount; but the amount at that time and place is not the lap meant by the general definition of that term, although some engineers use it in that sense as mentioned by Mr. Stewart. When they do, it amounts to a matter of convenience which custom may perhaps in time ratify; but why not stick to the original definition, not simply because our grandfathers used it, but because it fills all requirements when properly understood and applied. The more meanings a term may have, the greater the chance for misunderstanding, of which we have plenty at present.

CHARLES J. MASON.

## Governing Engines to Drive Centrifugal Pumps

THE ARTICLE on this subject, by Sterling H. Bunnell, in the Dec. 1 issue was very interesting and moves me to add a few points along this line.

The article dwelt on high-speed engines with shaft and throttle governors direct-connected to centrifugal pumps.

Mr. Bunnell states that the proper governing device is the throttle governor with hand adjusting cutoff, being preferable to shaft governors. This I believe is true for small units or where the investment will not justify greater expenditure; but for large units, the Corliss engine cannot be surpassed for economy and variable speed adjustments. I have operated Corliss engines at half their rated speed on the cutoff to full speed, the dashpots giving no trouble and needing no adjustment.

If the speed of the engine having a shaft governor has to be changed, it is a good idea to note the change made; that is, if the tension on the spring is decreased or increased one turn or part of a turn of the nut, or weight is added or decreased on the governor arms, or there are any other adjustments, make a note of it, and also the head against which the pump is working and other conditions, also the change in speed after adjustment.

After a few adjustments under different conditions, you will have enough information to know just the proper adjustment to make to get the desired results. If a change of speed is required for only a short period, adjust it with the throttle.

The article also states that with shaft governors the engine is liable to become overloaded, due to head decreasing on pump, and may cause the engine to develop a crack in frame or crank shaft, or go to pieces under load. This can be remedied by fixing the governor arm stop, so that the cutoff will not be longer than to give the capacity of the engine.

L. K.

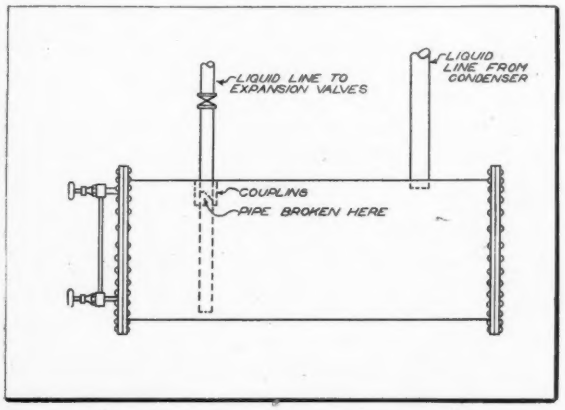
## Long Range Cutoff

IN THE Nov. 15 issue, Mr. Palmer's questions 54 and 55, I find something which seems to require further elucidation. Some engines with double eccentrics have range of cutoff to full stroke, but they are comparatively few; in more the range is half stroke. I have seen double eccentric engines with a range of less than half stroke, but only one engine which would cut off at full stroke.

As a matter of fact, it is impracticable to have an engine take steam full stroke. The exhaust valve should open before the end of the stroke, and the moment it does, steam blows straight through. An engine taking steam full stroke will not only throw away a lot of steam, but it will get "logy." There are many double eccentric engines that have a range of cutoff of less than full stroke, and long range cutoff does not mean full stroke cutoff, but a range of from zero to more than half stroke. WILLIAM E. DIXON.

## A Leak that Caused Trouble

THE GLASS gage on a horizontal liquid ammonia receiver showed the receiver to be ¾ full while the compressor was operating with full load, still there was every indication of a shortage of ammonia or a large amount of permanent gases. The condensers were purged, but little gas was in them. More ammonia was then put in the system till the glass showed full. While the expansion valves, of which there were 8 handling direct expansion coils in chill rooms, were all being used, everything went fine and the condenser pressure was 210 instead of 245 as it had been. The liquid line also cooled down to normal where it had been hot before.




LIQUID RECEIVER SHOWING BROKEN PIPE

Then, when only 3 or 4 expansion valves were in use, the charge of ammonia was so great that the compressor could only be handled with the greatest care and difficulty. Some of the ammonia was withdrawn with the result that no work could be done, high condenser pressure, and hot liquid line to expansion valves.

The receiver was built in the usual way, with the liquid outlet extending to near the bottom. It was found that this pipe was broken nearly in two at the top of the inside of the receiver. This break allowed the liquid to lie in the receiver and the light gas to enter the expansion valves. A. G. SOLOMON.

## Cause of Wear on Cylinder

ON PAGE 1164 of Dec. 1 issue, I noticed a method to determine whether the crosshead on a Corliss engine had, through wear or improper adjustment, dropped enough to make the piston wear the top of the cylinder excessively.

While I believe this method to be very good, "after the horse is stolen," I think the better way is to be sure of the proper adjustment at all times.

Upon making my first adjustment, I determine the exact center of the guides by means of dividers and at the extreme head end make a prick punch mark. Then I move the engine to approximately the crank center and make another mark under the first place on the rod that shows it has been through the packing.

After making the adjustment of crosshead shoe, with engine at crank center, I caliper first under the head end of the rod and then under the crank end.

This method will work by marking the same guide (lower one is handier) for either over or under running and will prove up for either guide or shoe wear.

H. U. COOPER.

## Engine Economy

I NOTICE, in Dec. 1 issue, a discussion of the question, "What parts of an engine must have the most attention to get the most economy out of the steam?"

Economy, of course, means to operate an engine without unnecessary expense. The first step in economy is absolute cleanliness. Let this be every engineer's slogan and see if his superiors will criticize him on their inspections. Cleanliness is to be seen everywhere. He will have boiler tubes, inside and out, feed pipes, in fact everything, clean.

Steam engine economy depends upon its master. The engine will be noisy when running if in need of attention, but not all of us can understand its language. If an engineer runs an engine for a year, he and the engine should understand each other pretty well, and if the engine gets a loose piston it will call his attention to it at crankpin headquarters. There is no part of the engine that the maker gives a purchaser free; therefore, see to every part of it, and inspect foundations closely. Don't let any oil soak into the foundation. If an engine has to be reset, it costs the same kind of dollars that it takes to pay for reboring a cylinder.

Every plant, unless it has a self-oiling engine, should have an oiling system so as to run the oil in a stream on all bearings. This keeps the bearings flushed out at all times and no dirty or discolored oil remains in the working parts. If the engine is open, a housing can be built around crank disk and eccentrics, and you can feed plenty of oil and it will not be thrown out on the floor. Filter the oil over and over, the more the better. If no wear exists in any bearing, that's economy.

Take indicator cards at least every 30 days; get the valves set right and let them alone. Leaving the wrench board alone is economy. Using red metal on pistons is economy. The packing rings will not wear the cylinder to speak of. Reboring costs money and causes the engine to be out of commission. Use metallic packing on every valve stem and piston rod; this reduces friction and will not disturb the governor. The governor has a responsible position and should be treated with the utmost courtesy.

Of course, there are engines that will not conduct themselves properly, no matter how well you treat them. That is not their fault; it is the way they were made, which is not always the engine builder's fault. If you sum up the whole thing, the men furnishing the funds

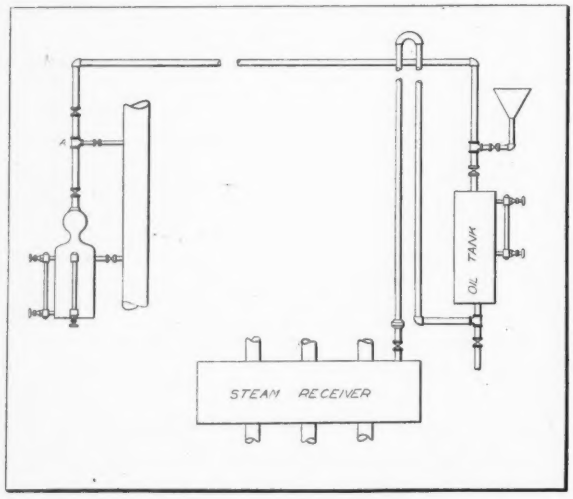
for the engine give the lowest bidder the contract. This lowest bidder cannot build this particular engine right for that money, but he will have the name of selling the engine. He is not going to black lead and spot everything; 1/64 in. is good enough. This is fake economy and no man can run this engine economically. Those who have the money to buy engines are not engineers, and seldom consult operating engineers.

To buy a good engine and take care of it is economy. Give it wholesome food and plenty of currying.

A. SUBSCRIBER.

## Oiling System

SINCE W. F.'s inquiry in regard to his oiling has been replied to by several contributors, I can also assure him that he will have no more trouble if he will follow the method as herewith reproduced. Instead of the




MR. SHERIDAN'S REMEDY FOR OILING SYSTEM

elbow, I replaced it with a tee, shown at A, and if necessary for any reason, the lubricator can be operated independently of the oiling system by manipulating the proper valves.

JAS. G. SHERIDAN.

I HAVE been much interested in the drawings and remarks about oiling systems in recent issues of Practical Engineer.

In the plant where I work, we have a system which may be a little out of date but certainly produces results.

The storage or filling tank shown in the accompanying sketch was made from a 10-in. pipe, threaded, with a cap screwed on one end and tapped for a 1¼-in. pipe which leads to the oil tank proper and on which is placed a valve. The top is left open, except for a wire screen that acts as a strainer. This tank holds enough oil to fill the oil tank which is made from a piece of 6-in. pipe threaded on both ends, capped and tapped on the bottom for a 1¼-in. drain pipe, and on the top for a ½-in. oil pipe. Near the bottom on one side it is tapped for the steam pipe which is connected to an overhead steam main leading directly to the boilers.

To fill the oil tank after filling the storage tank, close the valve on the steam pipe, also the valve on the oil pipe line. Open the valve on the line between storage and oil tank, also the valve on drain pipe at

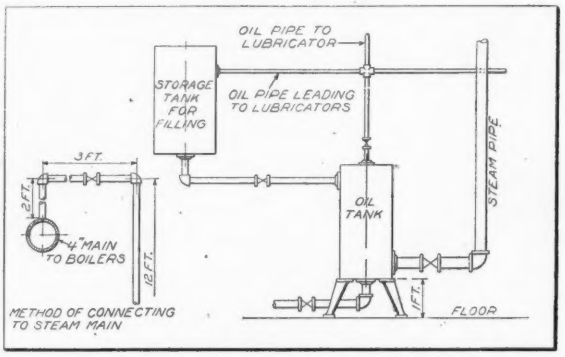



DIAGRAM OF EFFECTIVE OILING SYSTEM

bottom, and the pet cock on top of the oil tank. In the course of 8 or 10 min., about 6 gal. of oil are ready for the lubricators. There are 8 lubricators connected to the oil line, the farthest one something like 50 ft. away.

C. A.

## Friction and Engine Losses

WHAT Mr. Armstrong has to say, in Dec. 1 issue, on Friction and Engine Economy, criticising an article by the writer in the issue of Oct. 1, is quite true regarding the enormous amount of friction that can be produced in piston rod packing, and the criticism is accepted in the kindly spirit in which it is made. But after all is said and done, the fact still remains that for one case where there is a lack of economy in the use of steam due to frictional losses in the packing, there are a dozen engines where part of the steam leaks from the boiler into the exhaust head without doing its share of the work.

Today, more than ever before, some form of metallic packing is being used on rods and stems, and the principle of construction in most of them is such that the friction is almost negligible, as the spring tension is usually just enough to hold the several segments of the packing in the proper position, and these parts being machined to size and further refined by wear, hug the rod an absolutely tight fit with little friction.

The soft or fibrous packings today are better made than ever before, the result of careful study of the numerous conditions governing their use, and as a general thing a rod or stem packed with care and the right kind of packing to meet the conditions at hand, can usually be run with the gland nuts not much more than hand tight.

It is admitted that there are some engineers who do tighten the glands on rods and stems too much, to the detriment of the coal pile; but they are not many when compared with the vast number of engines whose valves and pistons let from 2 to 10 per cent of the steam slip past.

The writer has changed soft packing all around on a compound Corliss engine, but the log did not reveal any change in the general economy.

There is no doubt that the eminent men mentioned by Mr. Armstrong have found from 10 to 50 per cent increase in the friction by changing from a good to a poor packing; but, assuming a certain everyday standard as generally encountered in operation, suppose that the friction were increased 10 per cent on a piston rod. for instance, how long would it be until the packing burned or scored the rod? Not very long. One can do many things as a laboratory test that have no place in the practical everyday operating field.

As to the effect of friction on shaft governors, some engine builders use a valve with an inside admission so that the stuffing box need be only tight enough to retain exhaust steam, and even here, to relieve the governor and its delicate balance further from undue interference, the rod stuffing box is but a long sleeve and the rod is provided with water grooves, and 0.001 in. smaller.

An instance where a little extra friction on the valve stem came under the notice of the writer a number of years ago when testing engineer for a concern building small vertical engines: The one being tested was an 8 by 8-in. vertical direct-connected to a 25-kw. generator, and as the purchaser was "waiting at the depot with a wagon" at the other end, we worked a day and night and nearly another day but could not get regulation within about 3 per cent with changes in the load.

The second day, seeing that the valve stem ought to have another ring of packing, I removed the gland to insert a ring, when I found a bright spot on the stem, that was hidden by the gland when in operation. Investigation revealed a sprung stem, and with no other changes than a new stem, the regulation was within 1 per cent and the engine shipped.

It is quite true that eccentrics will slip, rods break, and stems twist or break entirely, owing to friction set up by lack of cylinder oil. Then what do they do on ocean liners, where they do not use cylinder oil at all on account of returning the condensate from the surface condenser to the boilers?

After an engine gets warmed up, the friction load reduces considerably in a few hours, as witness "blue Monday" in many plants that shut down over Sunday. Watch the condensation that escapes from the exhaust head drain the first thing Monday morning or, better still, weigh it for a given time, say 5 min., and then repeat the test later when the engines get warmed up.

Part of this difference is caused by temperature losses in the cylinder and piping, part by friction, not only in the packing, but elsewhere, and part,—a big part,—by leaks in the valves and cylinder, owing to the fact that while these parts may be tight under all normal operating conditions when hot and at a constant temperature, as soon as the engine cools off when idle, the valves and piston change their shape owing to unequal expansion and contraction, when they naturally leak until the temperature is again reached where they operate normally; then they become as tight as before.

Indeed, a Corliss valve has been noted to be distorted 0.015 in. when cold, yet when hot was bottle tight. Large flat valves are also subject to distortion through temperature changes, one reason why it is best to carry constant steam pressure in preference to fluctuating.

The writer was once sent to a little electric light plant on the fringes of civilization to "prescribe" for a little engine with a large appetite for steam. This being a contract job, the only valve between the boiler and the exhaust head was the throttle, and it leaked. Distortion from too frequent temperature changes, assisted by a 22-cent cylinder oil, soon started leaks in all 4 valves, and at the time referred to, these reached that point where from 0.006 to 0.01 in. on the thickness gage could be inserted between the valve and the seat, with the ends both touching.

So bad had the trouble become, that it took both boilers (one was presumed to be a spare one) to furnish steam. After the cylinder and valves had been put in first class condition by reboring, one boiler again did the work easily, and the fuel bill was cut in half with a little thrown in for good measure.

As for the air-brake, while it is true that it takes longer to bring a given train to speed than it does to stop it, the brake acts through a series of levers of the first and second class, which requires a movement of a foot or more of the brake piston to cause the brake shoes to travel a space of about an inch between the position of "release" and "application."

A small quantity of air is stored at a high pressure by the air pump, taking possibly 5 min. for it to complete the task for the average train, and to charge the train pipe. This entire quantity of air is available instantly to apply the brakes, and it is entirely possible for the engineer in the cab to throw the brake lever into the emergency, or "give her the big hole," as it is called, with such suddenness as to bring every car up on end, and injure every passenger or damage the contents of every freight car in the entire train.

GEO. H. WALLACE.

## Boiler Repairs and the Outcome

IN PASSING through a small town considerable excitement was noticed around the depot; it was found to be caused by a boiler explosion said to have occurred 2 hr. earlier in a woodworking plant a half mile down the track. When we reached the plant the machinery was at a standstill, while the engineer and a helper were busily engaged on top of 1 of the 2 boilers. On inquiry, it was found that one of the tubes had to be replaced in No. 2 boiler, and as the boilermaker had to travel several miles to make the replacement, it had been considered advisable to test the tightness of the job before his departure—the boilermaker advising the engineer thus:

"As you don't want to get up steam while I wait, we'll take a chance on it by pumping the boiler full of water and, the stop valve being closed, no harm will result, as water cannot get into the main steam pipe." The boilermaker did not state how serious the taking a chance might prove to be, but said: "We do it right along."

When the water had risen above the top of the gage glass and the boiler was filled, as the steam gage indicated a rise in pressure, a loud report was heard and the boiler room soon filled with steam.

As soon as possible, the engineer closed the stop valve on No. 1 boiler and an investigation began.

Figure 1 shows what was found, a piece of the body of the iron stop valve had been broken from the valve due to the severe strains the metal received from the high temperature of the steam on one side and the chilling effect of the comparatively cold water on the other.

The damaged valve had to be removed and a blank flange secured to the main, into which No. 2 boiler discharged and the plant run thus until a new stop valve could be obtained.

This shows that if ordinary care had been taken not to resort to such practice of testing for leakage much expense and the engineer's reputation could have been saved.

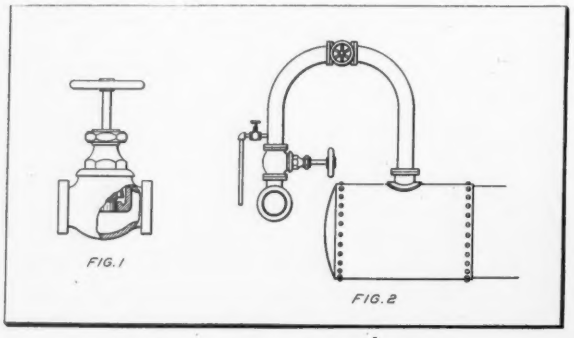



FIG. 1. HOW VALVE WAS DAMAGED
FIG. 2. PROPER WAY OF CONNECTING HEADER TO BOILER

It is good practice always to have 2 stop valves on each connection from each boiler to the main with a suitable drip between and if so piped the boiler in question could have been tested safely, as the space between the valves would radiate the heat communicated from the valve nearest to the steam main and the drip would remove any leakage past either valve.

Expansion and contraction strains do much damage and the engineer should always consider carefully their bearings on any job that comes up. RECEIVER.

## A Rolling Stone

I HAVE read A. C. Waldron's interesting contribution, Odd Devices in Power Plants, and certainly benefited thereby in added knowledge. But, contrary to Mr. Waldron's statement, "A rolling stone gathers moss" (I have changed the old saying slightly in accordance with his views), I am not a rolling stone. I therefore beg to differ slightly.

A man needn't be a rolling stone nowadays to get practical knowledge, with so many good practical engineering journals constantly appearing under fresh covers bearing new and interesting information such as Mr. Waldron's. All that is necessary is to read, study, think.

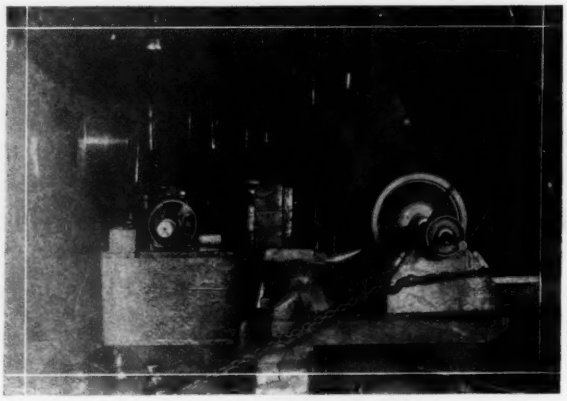
For instance, it probably took several years for Mr. Waldron to gather the information that he described in pictures and words that I consumed in a few minutes' study. Who has the advantage—he or I? Mr. Waldron doubtless has the advantage in actual experience, but I have the advantage in matter pertaining to time, and at the same time I have the imaginary experience.

Hence, I believe the old adage is still worthy of bearing in mind—"A rolling stone gathers no moss." Moss is usually understood to mean "money," however, instead of experience.

True, Mr. Waldron is right, but I do not think he would say it is *best* to roll or shift. N. G. NEAR.

## Reboring Engine Cylinders

WE HAD a machinist come to our plant to rebore the cylinders of one of our 3-cylinder gas engines. As the engines are of the vertical type and quite high, it was necessary to locate the driving gears of the boring bar near the ceiling of the engine room. We furnished a small motor to drive the boring bar, but its speed was too fast to drive direct from the reducing gears to the motor, so a jack-shaft had to be placed between the motor and the boring gear. The machine company furnished the jack-shaft pulleys and bearing. The bearings were mounted on wood blocks. The machinist spiked these blocks to a wood frame that we had, then set it up on 2 timbers to make the belt reach. First he braced



CHAINING DOWN THE COUNTER SHAFT

the frame in front, then put 2 anvils on the back to hold it down. This did not prove successful, as the belt would slide the frame sidewise and cause it to run off.

Then the engineer hit on the idea of hog-chaining it as shown in the cut. A long chain was hitched around one of the blocks and the other end hitched at another point in the engine room, allowing the sag to come within about 3 in. from the floor. Then the cap casting of the outboard bearing was laid across the chain, which drew the block back into place and held it until the cut was finished. L. M. JOHNSON.

LAST SUMMER, the Monongahela Valley Traction Co., whose system operates in northern West Virginia in parts of Marion, Harrison and Lewis Counties, found its water supply for steam making so pollutted during the dry season that the boilers were corroded. An auxiliary plant was planned and has been installed at Hutchinson, composed of 3 1250-kw. gas engine driven units, with space provided for 7 more if needed in a building of concrete, 72 by 211 ft. The fuel will be natural gas.

The steam turbine plant of 3000 kw. at Jayenne will be put in first class condition for emergency and breakdown service.

# Questions Answered and For Answer

*Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp*

## Boiler Problems

How do you determine the spacing of braces, and size of rivets to be used, assuming 12 braces, 1⅛ in. on a 66-in. boiler having an 18-in. segment?

2. How would you figure the area of a pop and a lever safety valve for a boiler 72 in. diameter, grate area 36 in., pressure 125 lb.?

3. Why are some of the tubes on the mud drum of a Stirling boiler beaded; should the ends of tubes and nipples be flared or beaded, and why? C. M. S.

A. The first problem is to find the area of the segment of the boiler which is to be braced. The area of this segment should be inclosed by lines drawn 3 in. from the shell, and 2 in. from the tubes, this being found in the present case to be 450 sq. in.

You assume 12 braces. Then, dividing 450 by 12, gives 37.5 sq. in. as the required area to be stayed by each brace, or, extracting the square root of 37.5 = 6.1 in. as the side of a square that each brace supports.

Let us assume also that the material to be used for braces has a tensile strength of 38,000 lb. per sq. in. of area and using 6 as a factor of safety, this gives 6333 lb. as the maximum strain that can be put on each brace, per square inch of area.

The area of a round brace 1.125 in. in diameter is 0.994 sq. in. Then multiplying 6333 by 0.994 gives us 6295 lb. as the total strain that can be put on each brace. Dividing 6295 by 37.5, which is the area each brace stays, gives us 167 lb. pressure that can safely be carried on a head of the size mentioned and stayed according to your inquiry.

If the brace be riveted to the head with 2 rivets, which is usually done, the strain of each rivet will be ½ of 6395, or 3147 lb. The strain on the rivets is one of tension entirely, so far as the connection to the head is concerned, and as good rivets have a tensile strength of 55,000 lb. per sq. in., it would be possible, as far as actual strength is concerned, to use a smaller rivet than is usual, but rivets in boiler construction subjected to strain of internal pressure are never less in diameter than the thickness of the sheet.

A boiler 66 in. in diameter, to carry 167 lb. pressure, would have to be constructed of 60,000 lb. tensile strength steel ½ in. thick, with a double riveted joint with drilled holes, or its equivalent. In this case the head would be ⅝ in. thick, which would require that the rivets holding the brace to the heads should be at least the same diameter, but as a matter of fact they are made the next size larger, or 11/16 in., or possibly even ¾ in.

2. There is a rule of thumb governing the area of pop and lever safety valves which allows 2 sq. ft. of grate surface for every square inch of valve area with a lever safety valve, and 3 sq. ft. of grate area per square inch of valve area for a pop valve. While this crude rule is at best a makeshift and was more or less the standard in the days gone by when boiler sizes and pressures were much less than now, it can no longer be recognized as trustworthy from the modern point of view.

As a matter of fact, the size of the safety valve required depends upon the quantity of water evaporated in a given time, usually an hour, and this in turn depends upon the grate area, and this again upon the quantity of coal burned per square foot of grate surface per hour and the heat value thereof. If any other fuel be used, the proper calculations must be made for it on the same basis.

All of these things are in turn dependent somewhat upon the boiler design, construction, manner of installation, care, intensity of draft and even upon the reading of the thermometer and barometer.

The lever safety valve, as applied to steam boilers of large size and high pressure, is fast passing into disuse. The rules of the United States Supervising Inspectors prohibit the use of the lever safety valve on all boilers built for steam vessels after June 30, 1906.

Your inquiry, however, does not supply the necessary data in order to be properly answered, so we will assume that your conditions are such that you are burning 20 lb. of coal per square foot of grate surface per hour and are evaporating 10 lb. of water per pound of coal as burned.

The formula laid down by the Government Board of Supervising Inspectors is as follows:

$$A = 0.2074 \times (W \div P), \text{ in which}$$

A = area of safety valve in square inches per square foot of grate surface; W = pounds of water evaporated per square foot of grate surface per hour, and P = absolute pressure per square inch (gage pressure plus 15).

Assuming 200 lb. of water evaporated per hour per square foot of grate surface, at a pressure of 140 lb. absolute, then substituting the figures at hand for the letters in the formula, we have:

$A = 0.2074 \times (200 \div 140)$.

$200 \div 140 = 1.428$.

$1.429 \times 0.2074 = 0.296$ = area of valve for 1 sq. ft. of grate surface,

$0.296 \times 36 = 10.656$ = area of valve in square inches for the conditions in the data at hand. Then, $10.656 \div 0.7854$ gives 13.57, which is the area of a square, one side of which is the diameter of an inscribed circle containing 10.656 sq. in., and which is the diameter of the valve.

Extracting the square root of 13.57 gives 3.69 in. as the diameter of the safety valve. In practice, the next size larger, or 4 in., would be used.

3. There is no particular reason why tubes in a Stirling boiler should be beaded in the mud drum any more than in any other drum, as far as actual safety is concerned, for it is general practice not to bead tubes in water-tube boilers, but simply to flare them ⅛ in. and roll them.

There are places where, if the tubes were beaded, the frictional losses would be much reduced, thus assisting the circulation of the water in the boiler, and under certain conditions of impurity in the water it might be advantageous to bead the tubes to prevent early corrosion. Again, in many places in a number of types of water-tube boilers, if the tubes were beaded, it would be almost impossible to remove the tubes without damaging the tube holes in the sheet.

In fire-tube boilers it is customary to bead the tubes at both ends and especially at the end next the fire, otherwise the flared end, being somewhat removed from the cooling influences of the water in the boiler would soon become heated and gradually destroyed, whereas, when the tube is beaded, it becomes a part of the tube sheet itself and is subjected to the same temperature of fire and water as the tube sheet. GEO. H. WALLACE.

## Centrifugal Pump Questions

How DO you figure the horsepower and discharge of a centrifugal pump?

2. What regulates the height to which a centrifugal pump can deliver water?

3. What purpose do the rings serve?

4. In what manner does the shape of the runner affect the pressure? SUBSCRIBER.

A. It is assumed that the question refers to a pump already built and in service. The horsepower can then be ascertained by measuring the number of pounds of water per minute being pumped and the pressure at the discharge nozzle in feet. These multiplied together and divided by 33,000 give the net horsepower. The gross horsepower will be greater, as some allowance must be made for various hydraulic and mechanical losses, which vary in amount depending on the size and make of the pump, and are generally expressed in terms of efficiency. Thus, a pump having a guaranteed efficiency of 70 per cent would have losses amounting to 30 per cent; and after ascertaining the net horsepower, you would have to multiply by 100 ÷ 70 to get the gross horsepower required. This gross horsepower will, of course, be the brake horsepower that would have to be supplied to operate the pump.

2. This is controlled almost entirely by the speed and diameter of the impeller. Thus, we can pump water to the same height with a small impeller at high speed as we can with a large impeller at low speed.

3. It is supposed that the question refers to the diffusion ring; that is, the stationary ring surrounding the periphery of the impeller and containing the openings called diffusion vanes. The impeller imparts a high velocity to the water; but it is pressure that is desired rather than velocity, so some means must be provided for converting this velocity into pressure, and the diffusion vane is a most efficient way of accomplishing this. The vane is a gradually expanding opening receiving the water from the impeller at the smaller end and, as the water travels through the increasing area, its velocity is reduced and the energy contained must appear in some other form, and does so as pressure.

4. The shape of the runner does not affect the pressure; that is, any shape runner can be made to give the desired pressure, but different shapes of runners will give different results if attempt is made to vary the pressure. Thus, an impeller with backward curved vanes will give an increased capacity at constant speed if the pressure is lowered; an impeller with straight vanes will give a variable capacity at constant speed with a practically constant pressure, and an impeller with forward curved vanes will give a decreased capacity at constant speed as the pressure is reduced. J. D. C.

## Operating Engines from Same Gas Producer

IS IT practical to operate 2 4-cycle engines, one of 175 hp., and the other 25 hp., from the same suction gas producer, the 175-hp. engine to be located at producer and the 25-hp. 1000 ft. from it?

I understand the main difficulty would be in getting a sufficient supply of gas to the small engine.

Cannot this be overcome by means of an exhauster similar or the same as used with pressure producers and connecting it in the gas main between producer and small engine at producer end, driving it by means of a motor from generator driven by the large gas engine and by this means deliver gas to the small engine under slight pressure?

What size pipe and exhauster would be necessary?
W. M. G.

A. Your supposition is correct with regard to the difficulty of getting gas to the small engine, under the conditions mentioned.

Unquestionably, this can be taken care of by using some kind of an exhauster to force a supply of gas to the small engine. Just how much capacity or pressure would be needed, is a thing that can be determined only by experiment. It would be necessary to put in a fan and variable speed motor, and work it out by trial.

The fan should be of a size to supply about 2500 cu. ft. of gas per hour, but what pressure would be required, we have no idea.

As to the size pipe, this would be the same probably that would be used if the engine were connected close to the producer, or it might even be a little smaller, since the friction in the pipe would be taken care of by the exhauster fan, and a receiver can be placed close to the engine to take up slight variations in pressure. A. L. R.

## Boiler and Pump Questions

WHY IS the middle sheet of a boiler laid on top of the end sheets?

2. Where is the lap of seam larger, on the inside or outside of a boiler?

3. Why?

4. What is the difference of construction between a release valve and a pop valve?

5. What would you do in case you found a lap leak on a boiler?

6. How many valves are there in the steam end of a duplex pump?

7. How many ports are there in a duplex pump?

8. What keeps the piston from striking the head on a pump?

9. Why are the heads of a boiler heavier than the side sheet? C. S.

A. There are 2 reasons why the 2 end courses of a boiler shell lap over the third or middle section. First, the natural tendency for any enclosed vessel subjected to internal pressure is to assume a spherical shape, as for instance soap bubbles, or a common toy balloon, and the fact that a boiler is constructed of metal sheets of considerable resisting strength does not alter this natural law.

Thus it is that this natural tendency to force the boiler into a spherical shape is greatest at a point halfway between the heads, which is at the middle course. By lapping the end courses over the middle one, the former have a certain restraining influence over the latter; whereas, if the middle section or course overlapped the end courses, this restraining influence would not only be lacking, but the rivets would be subjected to a tension stress as well as a shearing stress.

Secondly, if the boiler be of the externally fired return-tubular type, the middle course is immediately over the bridge wall and, as it is here that the heat of the furnace impinges upon the boiler with the greatest intensity, the boiler would be subjected to harsh treatment, as scale would naturally form in the lowest part of the boiler to the detriment of the sheet over the bridge wall.

If you will study the location of loose scale in a return-tubular boiler that has been gradually cooled off and slowly emptied, you will generally find that the loose scale will form mostly over the bridge wall, even with the end courses lapping the middle course; and if the middle course laps the end ones, the opportunity for lodgement of loose scale here will be increased to the detriment of the life and safety of a boiler.

2 and 3. We presume that you refer to a butt-strap joint with cover plates inside and out, as a common lap joint must naturally have the same amount of lap both inside and out. In the construction of any type of butt-strap joint employing 2 cover plates, whether the joint be double-riveted or of a higher efficiency, the inside cover plate is the wider because this construction is more efficient than the reverse and it is easier to calk the joint and insure its being permanently tight, as there are 2 thicknesses of sheets under the calked joint, and expansion and contraction of the shell will have practically no effect on it.

4. In a general way, a pop valve and a release valve are much the same as now generally used; but there are some features that have been developed on the 2 types through study of conditions governing their operation. A release valve is some form of a valve with a spring set to resist the pressure under the valve disc, which is generally machined at an angle of 45 deg. and ground to a seat much like an ordinary globe valve.

Release valves are used where it is necessary to have some form of valve to relieve pressure in excess of a certain amount in case of accident, such as an engine cylinder, an air cylinder, a receiving tank for a compressor, or on the feed line of a boiler feed pump.

Relief valves on steam cylinders form an exit for steam and water entrapped in the cylinder after the closing of the exhaust valve in case of water entering the cylinder with the steam in sufficient quantities to damage the engine. Many cylinder heads are saved daily by the use of a relief valve set about 5 lb. above maximum boiler pressure.

In air and water lines or receptacles, a release valve is inserted in such a manner that it will guard against a dangerous excess pressure if all other exits are closed. A pop valve, on the other hand, is used almost exclusively on steam boilers where danger from explosion through lack of it would entail great loss of lives and property, and necessarily must be constructed in as rigid and perfect a manner as possible.

The discs and seats of pop valves, in addition to being machined at an angle of about 45 deg. and formed of bronze, nickel and other special metals suitable for the temperature and service conditions, have one of several forms of a blowback device. This blowback attachment consists of a lip, usually V or U shape inverted, and located on the disc or seat in such a manner that when the valve opens to relieve the boiler, the steam acts upon this lip, which virtually increases the area of the disc acted upon by the steam. The result is that the valve is compelled to remain open until the pressure is reduced a certain amount below the "popping" point. This reduction is usually regulated so as to be about 2 lb., or 3 at the most, although the amount of blowback can be regulated from a few ounces to several pounds reduction before the tension of the spring closes the valve.

5. In case a leak is discovered in the lap seam of a boiler, not an instant's delay should be lost in determining for a certainty just what it is, or is not. If it is caused by a rivet, calk it when the boiler pressure has been reduced entirely or at least low. Owing to the fact that we are all but human and are liable to err, it sometimes happens that a boiler sheet will have a defect in it that cannot be detected but that when punched and rolled, a fracture is set up in the ligaments between 2 or more adjacent holes. This fracture may not assert its weakness for months and years after the boiler is placed in service, and possibly never, but for some sudden strain, such as introducing cold water suddenly, opening the fire doors to cool off or cooling off too rapidly before washing out.

At any rate, the constant expansion and contraction will always tend to enlarge such fractures until eventually the fireman may be startled to see steam or water issuing from a place where it never had before. All things must have a beginning, and when they come, the man in charge must keep his head absolutely and use his brains. He should examine the seat of trouble carefully and if necessary call in an experienced boiler maker. Note that the word "experienced" is used. This means a sober man of years of actual experience actually making and repairing boilers where the personal factor is the all-absorbing one. Do not take a single chance. Cut the boiler out and shut down the entire establishment and tie up a whole railroad system sooner than take a long chance and demolish the plant

with another "mysterious" boiler explosion. Give the boiler the water test, note the nature of the leak and you can tell better the cause of it. Sometimes removing a rivet carefully near the center of the leak, will disclose the fracture in the rivet hole. It may be necessary to remove the entire course of the boiler and put in a new one, and it may be necessary only to put on a patch. At any rate, get a "boiler doctor" and don't run long chances.

6. The common duplex pump, as usually found in the every day plant, has but one valve for each steam cylinder. In the smaller sizes, both valves are located in one steam chest common to both cylinders.

7. In a duplex pump, there are 5 ports, the middle one, of course, being the common exhaust port; the ones nearest to it are the exhaust ports from either end of the cylinder, while the 2 extreme ports are the steam ports.

8. As the piston nears the end of the steam cylinder, it covers the exhaust port at that end, thus imprisoning a small amount of steam in the cylinder, which, being compressed by the advance of the piston actuated by steam on the other side, acts as a cushion. The early types of duplex pumps were exceptionally extravagant in the use of steam; but experience has refined designs so that, today, duplex pumps run with a striking clearance as low as $\frac{1}{8}$ in. When the steam end of a duplex pump approaches 10 or 12 in. in diameter, there is inserted a cushion valve between the 3 ports at either end of the cylinder, so that the amount of steam imprisoned in the end of the cylinder, as described above, can be allowed to bypass into the exhaust port through the cushion valve. In this way, only enough exhaust steam need be retained to cushion properly the reciprocating parts.

9. Boiler heads are made thicker than the shells to which they are attached in order better to resist the effect of bulging from internal pressure to a certain extent and to afford a suitable strong field for riveting the necessary braces or through bolts, also to compensate for the loss of material in the tube holes.

GEO. H. WALLACE.

## Flow of Water in 20-in. Pipe Line

WHAT WILL be the flow of water for an hour in a 20-in. pipe line, 5000 ft. long under reservoir pressure of 80 lb., with a 20-in. valve wide open?

What will be the flow under 80 lb. pressure if a 12-in. pipe is tapped in this 20-in. line? The 20-in. main leading from reservoir is 5000 ft. long and the 12-in. pipe is 12 ft. long. Of course, the 12-in. tap with the valve wide open would cut the pressure down; but the question that bothers me is, what would you figure the pressure at the tap of the 12-in. pipe with 12-in. valve wide open to be? The pressure on the 20-in. line is 80 lb. when or before we open the 12-in. valve. From Kent's hand-book I figure the flow of the 20-in., 5000 ft. under 80 lb. pressure will be about 20,000,000 gal. a day; but by not knowing what pressure would be at the end of this 20-in. line with the 12-in. valve open, I did not know how to go about this to figure the 12-ft. 12-in. pipe. J. V.

A. IF WE assume that there is 40-ft. head at the valve, which would amount to about 17¼ lb. pressure, the spouting velocity would be such as to pass 12.69 cu. ft. per square inch of area per minute. The area of the 12-in. valve will be 113 sq. in., so that the total amount passed per minute will be 1430 cu. ft. Multiplying this by 7½ gives the approximate number of gallons per minute through the 20-in. pipe. At a velocity of 1 ft. a second, the water through this 20-in. pipe would be 979 gal. per minute. Divide the total gallons per minute by 979, and it gives us the velocity, which is 11 ft. per second.

There do not seem to be any figures to show exactly what the friction loss is for such a speed as this; but from a curve an estimate can be made that the loss would be 2.7 ft. head for 100 ft. of pipe, or for 5000 ft. the loss would be 135 ft. head. This, added to the 40-ft. head that you have assumed at the valve, gives 175 ft. head used up in friction in the 20-in. pipe and the spouting velocity at the 12-in. outlet.

Eighty pounds pressure will amount to 185 ft. head approximately, and we have accounted for 175 ft. head, leaving us 10 ft., or about 4 lb. pressure for inaccuracy and friction through the valve opening, which would be somewhere near right.

Your calculation of 20,000,000 gal., for 24 hr., flowing through the 20-in. pipe line, is about right; although, of course, any calculations of this kind are not accurate, as the friction resistance for different pipes and different rates of flow varies a great deal, and the constants that we have for our computations cannot be accurately fixed.

In order to arrive at the values given above, we made the first computation assuming that there was 10-ft. head at the 12-in. opening, which did not use up enough head in the friction in the 20-in. pipe. We then jumped to 50-ft. head lost, which gave a little too much friction in the 20-in. pipe. The 40-ft. head gives about a reasonable value. A. L. R.

## Alternator Question

IN ANSWER to my electrical questions published in the Dec. 1 issue, I find that V. E. J. advocates bringing the alternator up to speed unexcited, throwing in main oil switch, then closing field switch and building voltage up to normal.

I would like to ask if it is possible to do this without adding any external reactance and still not create any great disturbance in alternator or lines. C. D.

A. This depends largely upon the design of the armature.

A great many machines have sufficient armature reactance so that this could be done successfully. In others of modern design, with low armature reactance, it would cause a considerable pull, or jerk, on the armature windings if this were done, and it would be better to have an outside reactance in series with the armature circuit when throwing into step, this reactance to be short-circuited and cut out after the machine is running.

Just how much reactance is desirable depends, as already intimated, on the design of the armature. It cannot be found except by trial. A. L. R.

# Problems For Discussion By Readers

*What Would You Do If You Had These Conditions To Meet?*

## Pumping Hot Water

I HAVE a cistern 12 ft. deep, 24 ft. long and 12 ft. wide. I run my condensed water from a condenser. It is about 180 deg. F. Does any reader know of any way to get it out regularly at that temperature, into an open tank about 10 ft. higher than the top of the cistern and about 68 ft. away on the level?

We carry from 80 to 100 lb. steam pressure.

G. W. H.

## Boiler Cleaning Trouble

I AM in charge of 4 400-hp. B. & W. boilers and I would like to ask the readers how they manage to turbine the outer nipples, those next to the brickwork, connecting the drums to the headers at front and rear of boiler. With the turbine we have, we cannot get it back far enough in the saddle to reach these outside tubes and nipples.

L. F. B.

## Method of Measuring Length of Boiler

ON PAGE 1175 of Dec. 1 issue, G. A. W. requests opinions as to the proper way of measuring the length of a Stirling, B. & W., or Heine boiler drum; also, as to whether there is any standard or accepted method.

The writer knows of no set rule or standard for measuring the drums of steam boilers, as this depends upon the purpose for which it is made and is arbitrary unless there is some specific object in giving the measurements.

Boiler drum measurements, as given by manufacturers, are nearly always the outside length of the drum or shell, including the projection of the heads.

The Babcock & Wilcox Co., manufacturers of the Stirling, Aultman and Taylor and Babcock and Wilcox boilers, generally give the measurements of their boiler drums from end to end of shell, not including the heads.

The overall length of shell or drum is really of little importance or service other than finding the maximum space occupied by the boiler, and to enable the draftsman or erecting engineers to figure for clearances, pipe work covering, and so forth.

For computing the cubical contents or steam space of the drums, the inside measurements or dimensions are taken. For finding the heating surface, only that part of the drum that is exposed to the gases of combustion is figured.

Dimensions of shell boilers are nearly always given in outside measurements; but if you wish to compute the exact cubical contents of the boiler or its volume, the inside measurements must be used.

C. E. ANDERSON.

## Good Engine Performance

M. C. M. SHOWS 4 indicator diagrams taken at different loads from a 20 by 36-in. long range cutoff engine, and asks if anyone can suggest a way to better the running of this engine. It is stated that the rated horsepower of the engine is 480 at 120 r.p.m. and 150 lb. steam pressure. Evidently the engine is carrying about all the load it will as the electrical load of 400 kw. equals about 536 hp., which would be about 80 per cent of the indicated horsepower of the engine, or 670 i.hp.

Considering the load and the diagrams, there is only one change that I would suggest and that is slight, and which is, to open the crank end exhaust a little earlier, as this end does not release the pressure quite as quickly as the head end does. The steam lines are good, and show that the ports and steam pipe are of ample size to prevent wiredrawing. If the engine is to carry this load a greater part of the time it might be advisable to reduce the compression slightly, but I do not think that the efficiency of the engine can be increased by any change in the valve setting, except as noted above, which would be slight.

J. C. HAWKINS.

## What Is Wrong?

THE STEAM gage connection shown in the Dec. 1 issue does not appear to me to be exactly right, although it may conform to the law. It appears to be upside down. In connecting up a gage as shown in the drawing referred to, the siphon is not needed, as the drop pipe will act as a water chamber which cannot be drained to the boiler. The section of the law pertaining to steam gages states as follows:

Sec. 13. Each boiler shall have a steam gage connected to the steam space of the boiler by a siphon or equivalent device, sufficiently large to fill the gage tube with water, and in such manner that the steam gage cannot be shut off from the boiler except by a cock with a T or lever handle, which shall be placed on the pipe near the gage.

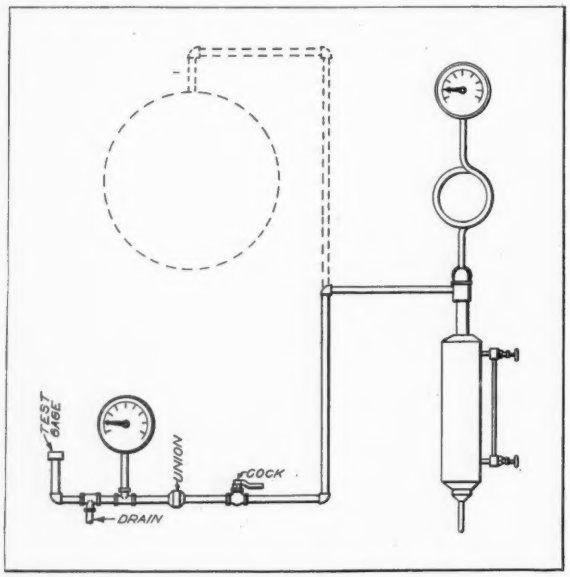
Sec. 15. Each boiler shall be provided with a ¼-in. pipe size connection for attaching the inspector's test gage when the boiler is in service, so that the accuracy of the boiler steam gage can be ascertained, as required by these laws.

In every gage that the writer has seen, the steam connection is at the bottom, and where the gage is placed below the level of the steam drum or water column, I should connect it up in the manner shown in the accompanying sketch, preferably to the steam space of the boiler instead of to the water column, as there may be valves in the water column connection (which

is allowed by law) which if closed would of course shut off the steam gage.

There should be a stop cock near the gage and a union between the cock and gage by means of which it may be disconnected with pressure on the boiler if necessary. There should also be a drip cock, and an inspector's test gage connection which may or may not have a stop cock, but should be capped when not in use to prevent dirt getting into it which might be blown into the test gage. In the sketch shown by Mr. Blake, the inspector would either have to use pipe and fitting to bring his gage right side up or stand on his head to read it, whereas in the connection shown herewith it is only necessary to take the cap off and screw the test gage in place.

The majority of the boilers in use in the United States today have a ¼-in. globe valve on the steam gage line near the water column of steam drum. The greatest objection I have to this practice is that they are a nuisance. They are either always leaking around the stuffing box, or are stuck and cannot be turned or else will not shut off tight, therefore the boiler is better off without them.




METHOD OF CONNECTING STEAM GAGE

When the steam gage is placed above the water level or in such position that the condensation in the connection pipe will be drained back into the boiler there should be a siphon or some other form of a loop whereby the water may be trapped in the pipe. This is shown on the right-hand side of the water column. I believe that the gage connections shown will give the same or better results, will be more convenient for the attachment of the test gage, whether the inspector's or the engineer's (the engineer should not depend entirely on the yearly visits of the inspector, but should test the gage himself occasionally), and will present a better appearance than the connections referred to.

One would naturally suppose that in a modern power plant owned and operated by "Uncle Sam," who has a host of expert designing engineers on hand, the boiler installation would conform strictly to the most rigid laws of the country, and would, in fact, set the example for the states in this respect. Such, however, is not the case. I have been in many Government power plants, and have never yet failed to find one or more conditions that would not be allowed in Ohio or Massachusetts. J. C. HAWKINS.

---

AFTER READING the answers given by the different readers of Practical Engineer to the question, What is Wrong? on page 1041, Oct. 15 issue, I am persuaded the errors have been pointed out; but none of them have accounted for the 2 errors in their answers.

In the issue of Nov. 15, page 1131, E. L. C. has discovered one error in the piping up of the steam gage. In the issue of Dec. 1, page 1174, John H. Linton has pointed out the other, the manner in which the safety valve is connected to the boiler.

The Massachusetts Boiler Rules in Part 2, Section 2, paragraph 6, declares that each safety valve shall have full-sized direct connection to the boiler. Mr. Linton points out to us the 2 reducers or bushings between the safety valve and boiler. I believe the original hole in the boiler for the accommodation of the safety valve must be the right size, therefore the safety valve is too small.

In regard to the valve between the damper regulator and the boiler, Mr. Linton gives W. T. Meinzer credit for discovering an error in it; according to the Massachusetts Boiler Rules, the valve is in its proper place. Paragraph 21 of the above-mentioned Part and Section declares that when a damper regulator is used, the boiler pressure pipe shall be fitted with a valve or cock, and shall be connected to the steam space of the boiler in such a manner that the damper regulator cannot be shut off from the boiler except by such valve or cock. DAVID FLEMING.

---

## Size of Connection

I WISH to say that in the Dec. 1 issue, p. 1174, What Is Wrong, I meant to specify the size of the connection for attaching the inspector's gage and not the connection from the top of water column to gage, as ¼ in. Especially on a large boiler, ½ or ⅝-in. would be more in proportion. LE ROY BLAKE,

---

AMONG the packing box and crating material required by one firm were large reels upon which wire was coiled for shipment. In making these reels, it had been customary to mark out with a compass the circle outlining the heads. They were then cut out on the band saw and it required careful guiding to follow the line and thus keep to a true circle.

A small fixture attached to the table of the band saw allowed an upright bolt to be carried which could be stuck through a center hole in the material from which a head was to be sawed. It was then simply a matter of turning the head around this center bolt which operation fed the material into the saw in a true circle.

It required practically no care in feeding. A large saving was made by this simple arrangement.—G. G. H., in Factory.

# Bearing Metals

THEIR COMPOSITION AND PROPERTIES. BY W. H. PEARSON

REAL babbit metal consists of 88.9 parts of tin, 7.4 parts of antimony, and 3.7 parts of copper. The properties which make babbit valuable are its power of accommodating itself to a hard, unyielding surface, its capacity of taking a polish, its power of resisting certain chemicals. Generally, it will not cut, scratch, or heat the journal, and after being in use for some time, the bearing takes a good polish.

Variations in the genuine metal are limited, but the commercial grades sold for babbit metal are various; in some of the cheaper grades there is no tin in the mixture. A cheap metal with a lead or zinc base, well made, may give better service than a more costly metal which has been carelessly mixed.

## GRADES

COMMERCIALLY, the metal is generally sold as No. 1, 2, 3, 4. The No. 1 metal is for light loads and high speeds; No. 2, medium loads and moderate speeds; No. 3, heavy loads and slow or moderate speeds; No. 4, heavy loads and high speeds. The hardness generally increases with the numbers. In some of the common stock babbit the metal sold as No. 4 contains about 77 per cent lead, 20 per cent antimony, 1 per cent each copper and tin. No. 1 contains about 20 per cent tin, No. 2 about 12 per cent tin, and No. 3 about 5 per cent tin.

A cheap metal can be made of 8 parts of lead to 1 of antimony. The metals are sometimes classified as: 1, the tin series; 2, the lead series; 3, the zinc series. Tin is the base of most of the best antifriction alloys. Lead is the best antifriction medium among metals, but lacks stiffness to stand up to the work. Zinc is the most expansible and durable. Zinc babbits wear well and fit snugly to the bearing. Antimony is the hardening element.

## PREPARING THE METAL

IN PREPARING metals, the hardening elements are first made. Babbit's hardening may be made by melting 4 parts copper, then gradually adding tin 12 parts, antimony 8 and, finally, a further addition of tin, 12 parts; this is cast into ingots and, when making up a batch of metal, is added to the base. This hardening mixture should be made in a plumbago crucible, such as is used for melting brass.

To make up a batch of metal, melt the metal which forms the base, which may be tin or lead, of the alloy in an iron pot, and dissolve the hardening therein, at a gentle heat, using tallow or powdered sal ammoniac as a flux. If zinc forms the base of the metal, it should not be melted in an iron pot, but in a plumbago crucible, from which it may be poured and mixed with the other metals already melted in an iron pot.

## WEIGHT AND PRICE OF ALLOYS, EXAMPLE 1

A METAL consists of 10 parts tin, 1 of copper and 1 of antimony. What is the greatest quantity of metal that can be made out of 74 lb. of tin, 14 lb. of antimony and 8 lb. of copper?

Here the copper and antimony are 1/10 of the tin. Then 1/10 of 74 = 7.4 lb., the weight each of copper and antimony, and 74 of tin + 7.4 copper + 7.4 antimony = 88.8 lb. of metal.

Although we had 14 lb. of antimony, it does not follow that we must use the whole of it, so long as we have sufficient to mix with the tin in proper proportion. The same remark applies to the copper.

## EXAMPLE 2

WHAT IS the greatest quantity of metal that can be made out of 194 lb. of tin, 17 lb. of antimony, and 14.5 lb. of copper, using the same proportions as before, 10-1-1?

Here the tenth part of 194 = 19.4 lb., which is the required weights of antimony and copper, but neither of them reach this. In such a case, take the least quantity given, which, in this case, is 14.5 lb. of copper, and count from it. As antimony is to be the same quantity as copper, it will be, therefore, 14.5 lb. The weight of tin is to be 10 times as much as copper; hence, $10 \times 14.5 = 145$ lb., and $145 + 14.5 + 14.5 = 174$ lb. of metal that could be made.

## EXAMPLE 3

HOW MUCH of each is contained in 144 lb. of the same metal?

| | | |
|---|---|---|
| Here, Tin = | 10/12 of 144 = | 120 lb. |
| Copper = | 1/12 of 144 = | 12 lb. |
| Antimony = | 1/12 of 144 = | 12 lb. |
| Total, | | 144 lb. |

## EXAMPLE 4

IF TIN costs 30c., copper 16c., and antimony 60c. a lb., what would be the cost of 32 lb. of the metal, using the same mixtures as above?

| | |
|---|---|
| 10 lb. tin at 30c. lb. | $3.00 |
| 1 lb. copper at 16c. lb. | .16 |
| 1 lb. antimony at 60c. lb. | .60 |
| 12 lb. metal costs | $3.76 |

Then 12 : 32 :: 3.76 : x, or $(32 \times 3.76) \div 12 =$ $10.03, the cost of 32 lb.

## EXAMPLE 5

A METAL contains 60 parts of copper and 40 parts of zinc; we require 35 lb. of it; how much of each shall be used?

| | |
|---|---|
| Copper | 60 lb. |
| Zinc | 40 lb. |
| Total metal | 100 lb. |
| Hence, 60/100 of 35 lb. = | 21 lb. |
| 40/100 of 35 lb. = | 14 lb. |
| Total, | 35 lb. |

Therefore we need 21 lb. of copper and 14 lb. of zinc to make the proper mixture.

In the Practical Reference Tables of this issue, are given a few special mixtures which have been used for the duty stated, also what are termed copper-hardened alloys, the copper contents being over 5 per cent; also some customary bearing pressures allowed for various classes of work, adapted from values in Halsey's Handbook for Machine Designers and Draftsmen. With the excellent metals now on the market, it would not be profitable to attempt to make a high grade mixture, as it requires skill, but the principles of mixtures are of value to the engineer, especially the younger man.

PRACTICAL
ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyrighted, 1915 by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,000.

CONTENTS

Air Lift for Water Supply. By Charles C. Phelps. Illustrated. ....103
A Portable Machine Shop. By J. C. Hawkins. Illustrated. ....106
Continuous Check on Steam Consumption. Illustrated..108
Centrifugal Pumps for Boiler Feed Service. By E. S. Adams. ....108
Electrification of Puget Sound Lines of the Chicago, Milwaukee & St. Paul Railway. Illustrated....110
Magnet-Operated Whistle. Illustrated....114
Iron Pipe Lined with Portland Cement. By N. J. Wilcox. Illustrated. ....114
The Automatic Reclosing Circuit Breaker. By E. C. Raney. Illustrated. ....115
Jeremiah Judson, C. E. Illustrated....117
The Decomposition of Ammonia. By A. G. Solomon...119
Setting Expansion Valves. By T. G. Thurston....120
Horsepower to Pump Water. By H. M. Nichols....122
It Happened in West Virginia. By N. Devering....123
Accident Relief and Service Pensions for Westinghouse Employes. ....125
Letters Direct from the Plant: Economy for the Steam Laundry. Lap of Steam Valves on a Corliss Engine. Governing Engines to Drive Centrifugal Pumps. Long Range Cutoff. A Leak that Caused Trouble. Cause of Wear on Cylinder. Engine Economy. Oiling System. Friction and Engine Losses. Boiler Repairs and the Outcome. A Rolling Stone. Reboring Engine Cylinders. Illustrated....125
Questions Answered and for Answer: Boiler Problems. Centrifugal Pump Questions. Operating Engines from the Same Gas Producer. Flow of Water in 20-In. Pipe Line. Boiler and Pump Questions. Alternator Question. ....131
Problems for Discussion by Readers: Pumping Hot Water. Boiler Cleaning Trouble. Method of Measuring Length of Boiler. Good Engine Performance. What Is Wrong? Illustrated....135
Bearing Metals. By W. H. Pearson....137
Editorial: Railway Electrification. Direct and Indirect Valves. ....138
Research Fellowships. ....139
Roto-Tube Cleaners for Fuel Economizers. Illustrated..140
Reactive Factor Meters. Illustrated....140
Turbo-Undergrate Blower. Illustrated....141
Hurricane Flue Cleaner. Illustrated....141
The Kincaid Stationary Stoker. Illustrated....142
Permeability Testing Outfit. Illustrated....143
Small Portable Air Compressor. Illustrated....143
News Notes ....144
Edward Daniel Meier....145
Fred Ulrich. ....146
Practical Reference Tables: Power to Pump Water. Common Bearing Metals. Bearing Pressures. Weight and Specific Gravity of Various Substances....147
Catalog Notes. ....149
Trade Notes. ....150

## Railway Electrification

Direct current voltage as applied to electric locomotives has again received a boost. It was only a few years ago that electrical engineers shook their heads in doubt when the first 1200-volt line was being developed, but we now accept a 3000-volt system as a thing of natural development and are tempted to remark, "Who'll make it 4000?"

There are other features about the electrification of the lines of the Chicago, Milwaukee & St. Paul Ry. which are described on other pages of this issue, which are worthy of more than passing note. The advantages of higher voltage need no comment except, perhaps, that in addition to the saving in transmission wires there is a great saving in substation equipment for, in this development, the substations are, on an average, 35 mi. apart, whereas with lower voltage, this distance must be reduced approximately in proportion to the voltage and the load carried.

Electrification of all railways in mountainous districts would be a long step towards saving our natural resources of coal, for in these regions, as in the case of the present development, the source of power is from streams which have heretofore run to waste, while heavy traffic over the mountains was hauled at enormous reduction to our coal supply.

Again, can there be any means more economical of power than the electric locomotive which, instead of employing friction brakes, is converted into a generator when descending a grade and thus helps to pull other trains on the division? An arrangement which not only utilizes a by-product but affords an excellent system of braking under perfect control.

This development is an historic step in the electrification of railway systems and its success will be watched with great interest.

## Index for 1904

The index to articles, reference tables, and authors for Vol. XVIII, 1914, of Practical Engineer is now read for distribution and will be sent to any subscriber who sends in a request for it.

## Direct and Indirect Valves

A problem appearing greatly to confuse many engineers is that of distinguishing between a direct and an indirect valve; and it must be admitted that some ambiguity does exist in the use of these terms.

Usually, "direct" refers to a valve driven so as to move in the same direction as the eccentric moves; an "indirect" valve has a rocker arm introduced which reverses the direction of motion of the valve.

If referring to the valve motion, the meaning would be as stated, while if talking about the manner in which the steam is handled by the valve, one might mean that any valve having an auxiliary cutoff is indirect. The confusion is due entirely to a question of a difference in definitions and might be argued forever.

Similar difficult seems to exist relative to the direct and indirect sides of a duplex pump. By studying any of the ordinary designs of pumps, it will be noted that, on one side, motion is communicated from the piston rod

to the valve stem in such a way that the 2 move in the same direction. On the other side, however, the connection is such that the valve is moved in the opposite direction to that in which the piston is traveling.

The side on which the valve moves in the same direction as the piston that drives it, is called the "direct" side, while the side on which the valve moves in the opposite direction from the piston which drives it, is called the indirect side.

## Research Fellowships

IN THE ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS

TO extend and strengthen the field of its graduate work in engineering, the University of Illinois has since 1907 maintained 10 Research Fellowships in the Engineering Experiment Station, for each of which there is an annual stipend of $500, open to graduates of approved American and foreign universities and technical schools. Appointments to these fellowships are made and must be accepted for 2 consecutive collegiate years, at the expiration of which period, if all requirements have been met, the Master's degree will be granted. Not more than half of the time of the Research Fellows is required in connection with the work of the department to which they are assigned, the remainder of the time being available for graduate study.

Nominations to fellowships, accompanied by assignments to special departments of the Engineering Station, are made from applications received by the Director of the Station each year not later than the 1st day of February. These nominations are made within the month of February by the station staff, subject to the approval of the Faculty of the Graduate School and the President of the University. Appointments are made in March, and take effect the 1st day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

Nominations to these fellowships are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself, preference being given those applicants who have had some practical engineering experience following their undergraduate work.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of carrying on investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State. Research work may be undertaken in architecture, architectural engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and in theoretical and applied mechanics.

The work of the Station is closely related to that of the College of Engineering, and the heads of departments in the College constitute the administrative Station Staff. Investigations are carried on by the members of the staff and other members of the instructional force of the College of Engineering, by special investigators employed by the Station, and by the Research Fellows.

Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

---

U. S. CIVIL SERVICE COMMISSION announces an examination for civil engineer student, on Feb. 3, 1915, to fill vacancies in this position in the Office of Public Roads, Dept. of Agriculture, at salaries of $720, all traveling expenses, and subsistence not to exceed 30 days on any one assignment, being paid by the department. Competitors will be examined in mathematics and mechanics, pure and applied, surveying, construction, and materials of construction. Graduation in civil engineering from a recognized school or college, or the fact that applicants are senior students in such institutions and expect to receive a degree in civil engineering prior to July 1, is a prerequisite for consideration for this position. Age, 20 yr. or over on the date of the examination. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312.

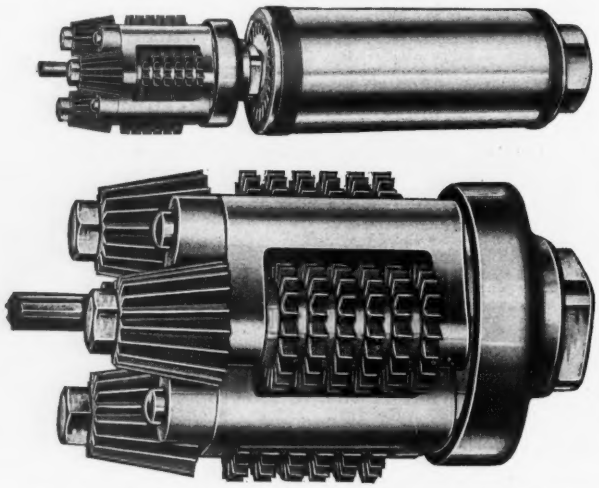
U. S. CIVIL SERVICE COMMISSION announces an examination for electrical draftsman, on Feb. 3 and 4, 1915, to fill vacancies in this position as they may occur at U. S. navy yards and naval establishments or in the Department at Washington, D. C., at entrance salaries ranging from $3.52 to $5.52 a day. For filling vacancies in navy yards or other naval establishments preference in certification will be given to eligibles residing in the vicinity of the place at which the vacancy occurs. Duties require the origination and supervising preparation of electrical installation plans aboard ship, power lighting, interior communication, radiotelegraphy, the designing of switchboards, writing up specifications for apparatus, estimating, checking plans, etc.; writing up descriptions, instructions for use, care and maintenance of the apparatus, and systems indicated above. The following subjects will have the relative weights indicated: Mathematics (including arithmetic, algebra to quadratics, geometry, plane trigonometry, and use of slide rule and logarithms), 10; electrical machinery and materials (including theory and practice of electricity in connection with machines, instruments, and appliances and material used), 20; drawing and design, 30; education, training, and experience, 40. A minimum rating of 80 per cent will be given on subject 4 to applicants who have a good common or high school education and 5 yr. suitable practical experience, of which 2 yr. have been employment in office drafting, or a degree in engineering from a technical school of good standing and 3 yr. additional practical experience, of which at least one must have been in office drafting. A minimum rating of 70 per cent will be given on subject 4 to applicants who have had a good common or high school education and 3½ yr. suitable experience, of which at least 1½ yr. have been in office drafting, or a degree in engineering from a technical school of recognized standing and 1½ yr. practical experience, of which at least 6 mo. must have been in office drafting. Age, 22 yr. or over on the date of the examination. Apply for Form 1312, giving the title Electrical Draftsman (Male).

# Power Apparatus in Shop and Market

*New Ideas In Making, Buying and Selling*

## Roto-Tube Cleaners for Fuel Economizers

CAST-IRON tubes of economizers are subject to corrosion, which pits and softens the inside of the tube and cleaning them with the ordinary type of boiler tube cleaner has resulted frequently in more rapid corrosion due to exposing the soft and thin spots to further and continuous eating away until the wall is penetrated and the tube destroyed. When cleaning tubes subject to corrosion it is best to leave the pits or depressions with a covering of scale, thus preventing the water from coming in contact with the metal and it is to accomplish this result, at the same time cleaning



THE NEW ROTO CUTTER HEAD CONNECTED TO MOTOR AND DETACHED

all other parts of the tube of scale, that the Roto-Tube cleaner illustrated here was developed by the Roto Co., of Hartford, Conn.

A parallel movement of the new head results from hinging the swing frames, which carry the cutters, on pivots parallel with the tube and on long, double supported, hinge pins, which hold them parallel. This construction insures a smooth, uniform tube surface. The comparatively long row of cutters moves evenly outward toward the wall of the tube, bridging over the low and soft spots, and the large cutter surface gives a low, safe pressure, considering the area, against the tube.

A limit ring allows the cutters to move out to a definite diameter only, which is adjustable, to compensate for the wear of the cutters. The ring is formed with a triple cam, which can be set in a desired angular position, and is held there by a projecting hinge pin. This angle sets the diameter to which the head will cut.

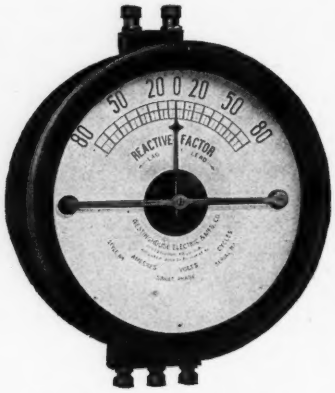
Another feature is a bumper, or stop stem, which prevents the cleaner from getting stuck in the lower header.

These heads are made to be driven by Roto motors, using either air or water. The motors are long and guided by hardened steel rings at their extreme ends, which keep the motor and cutter head well centered and in line with the tube.

## Reactive Factor Meters

THE art of electrical measurements has reached such a state of perfection that the introduction of a totally new type of instrument to measure a quantity not previously directly measurable becomes an event of great interest.

Although instructed to keep the power factor of the circuits over which they have control as near unity as possible, switchboard attendants often maintain a power factor of 1 or 2 per cent less than unity as being good and do not try to improve it. But computation and




REACTIVE FACTOR METER

tests show that a power factor of even only 1 or 2 per cent less than unity is not so good as it appears to many station attendants, especially on rotary converters. At 98½ per cent power factor, the armature copper loss in the leading tap coils of a rotary is almost half again as much as at 100 per cent power factor. Under heavy load, this is often enough to cause trouble in the tap coils. Also, the average heating in all the armature coils is about a quarter again as much at 98½ per cent power factor as at 100 per cent. The capacity of the rotary is therefore decreased considerably.

The measurements of "idle currents" is in general a recent development, wattmeters having been used recently so connected as to measure the idle volt-ampere, or "watt-

less component." The reactive factor meter, however, corresponds in its action to the power factor meter and bears the same relation to the latter, that the "wattless component meter" bears to the "wattmeter." This meter indicates the sine of the angle of lag or lead instead of the cosine as in the power factor meter. Unity power factor is, therefore, indicated as zero reactive factor.

If instead of the power factor meter, there is on the circuit a reactive factor meter, a condition of 98½ per cent power factor is indicated as 17½ per cent reactive factor, and the attendant will be more on the alert and will be more likely to improve it.

Power factor and reactive factor are equal at the value 70.7 per cent. At higher power factor, the load conditions are more conspicuously indicated on the reactive factor scale. At lower power factors the reverse is true. Reactive factor meters are therefore recommended for use only on circuits operating normally at power factors close to unity and which never fall below 70 per cent.

The Westinghouse Electric reactive factor meter, which has been introduced recently, operates on the rotating field principle like the Westinghouse power factor meters. A rotating field is produced in angularly-placed coils connected in shunt with the metered circuits, one for each phase of the system in the case of polyphase meters. In their field is provided a movable iron vane or armature, magnetized by a stationary coil whose current is proportional and in phase with that of the line current in one phase of the circuit. As the iron vane is attracted or repelled by the rotating field of the angularly-placed coils, it takes up a position where the zero of the rotating field occurs at the same instant as zero of its own field. Thus its position indicates the phase angle between the voltage and current of the circuit. The reactive factor meter is then calibrated to read the sine of the angle indicated, while the power factor meter is calibrated to read the cosine.

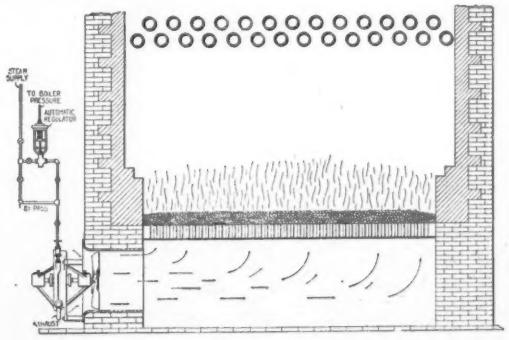
In the 3-phase meter, the rotating field is produced by 3 coils spaced 60 deg. apart; in the 2-phase meter, by 2 coils spaced 90 deg.; in the single-phase meter, the rotating field is produced by means of a split-phase winding connected to the voltage circuit.

The Westinghouse reactive factor meters are enclosed in round dust-proof cases, the type SI being 7 in. and the type TI 9 in. in diameter. The entire pointer is visible, so that readings are easily made from a distance. No springs are used to control the movement or carry current, nor are any moving coils, the construction being extremely simple. The meters are not influenced by external fields.

## Turbo-Undergrate Blower

DURING the month of May, a 9-hr. test was made at the Oliver Hotel, South Bend, Ind. The test was made on a 150-hp. B. & W. boiler equipped with a Nicholson furnace. In addition to the regular hotel load, the engine was put into service from 8:00 to 9:00 a.m., and from 2:00 to 3:00 p.m., to determine both the overload that could be carried on the boilers, and whether it could be maintained until another boiler was thrown into service. The boiler developed 309 hp. during the peak of the morning, which is 206 per cent of the rated capacity.

Thirty-eight pounds of breeze per square foot of grate surface per hour was burned. Abundance of air made possible the use of this coke breeze and this high rate of combustion. Coke breeze is a cheap, smokeless fuel and if forced draft is used can be burned at high combustion rates.



BLOWER INSTALLED IN A SOUTH BEND, IND., HOTEL

An abundant air supply that is so fundamental for developing overloads is furnished by an 18-in. Turbo-Undergrate Blower built by the B. F. Sturtevant Company, of Boston, Mass. This little blower was set right into the boiler brick work under the fire grate, as shown in illustration. The use of these undergrate blowers is increasing and makes it possible for overload plants to obtain additional steam.

## Hurricane Flue Cleaner

FREQUENT cleaning of boiler tubes adds to the steaming efficiency of a boiler and saves fuel.

Because of the unpleasant duty features connected with the ordinary flue blower, the job is put off from time to time—to the advantage of the coal dealer but not the one who pays the bills.

To make the job more attractive, the Hurricane Automatic Steam Flue Cleaner, illustrated here, was brought out.

HURRICANE AUTOMATIC STEAM FLUE CLEANER

It is entirely automatic in action; the pressing of a nozzle against the mouth of the tube opens the valve, admitting full force of steam into the tubes, forcing all soot and ashes into the back connections; when the nozzle is withdrawn, the valve closes instantly, shutting off the steam.

This automatic action prevents the current of steam from striking the boiler head and blowing soot and ashes around the boiler room. There is no water blown into the tubes, the valve being arranged to drain itself of condensation without leakage of steam. James L. Robertson & Sons, New York, are the manufacturers.

# The Kincaid Stationary Stoker

WHEN a sufficient number of very small charges of coal are distributed evenly over the fire at a rate in direct proportion to the consumption, if furnace proportions are correct, perfect combustion and smokelessness are secured with practically any grade of fuel. This principle is employed by the Kincaid stoker which is capable of delivering charges of coal ranging from 3 oz. to 2 lb., according to the capacity of the furnace to which it is attached.

With hand firing, one difficulty is that when fresh fuel is supplied to part of the furnace, the air supply to that portion of the grate on which it is thrown is partially shut off. This creates the condition of insufficient air in the proximity of the fresh fuel to give the proper combination of the volatile gases distilled and oxygen. At the same time, the draft forces more air than necessary through that portion of the grates, on which there is no fresh fuel. This excess has a chilling effect on the fire-box.

The Kincaid overcomes this difficulty by distributing small charges of coal evenly over the grate, covering every portion of it at the rate of 10 to 75 charges a minute, depending upon the requirements of the boiler. This builds up a fire which is light and spongy, and results in the air passing up through the fire evenly, thereby combining with the volatile gases in the proper proportions. This gives an even and high temperature over every portion of the grate.

The entire apparatus is hinged on a frame bolted to the boiler front, as shown in Fig. 1, and no change in setting or boiler front is required other than the removal of the fire-door, and the attachment of a fire-door frame. The stoker may easily be swung clear, as in Fig. 2, for cleaning the fire or for any other occasion that may arise.

Referring to Figs. 3 and 4, the coal is fed toward the furnace in regulated quantities by means of the worms and crusher rolls, A.

The crusher rolls make it possible to use coal of any size from slack to 8-in. lumps or even mixed sizes, such as run-of-mine. The coal drops into a rectangular space, B, directly in front of the ram, C. The ram is actuated by a steam piston (seen at the right of the hopper in Fig. 1). The worms, A, work intermittently so that when the ram is delivering a blow against the coal in space B, no coal is being fed forward. When the ram is withdrawn for the next blow, the same motion actuates the worms through a predetermined portion of a revolution. Thus, the same quantity of coal is fed to the ram for each successive blow. This quantity may readily be changed by changing the throw of the ratchet arm which turns the worms.

FIG. 1. KINCAID STOKER IN OPERATING POSITION

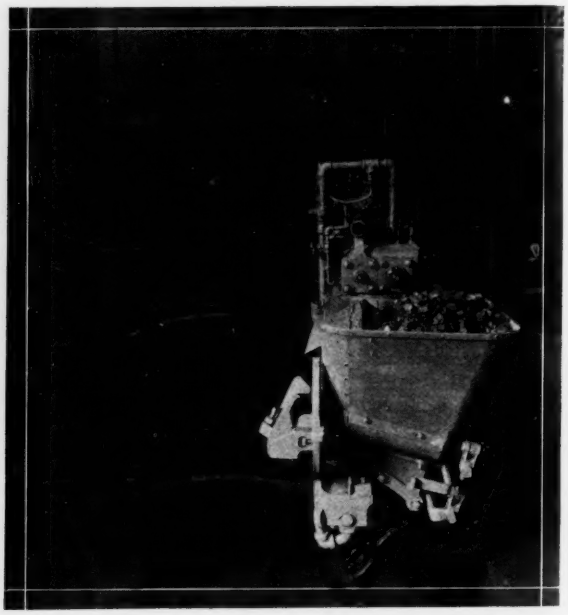


FIG. 2. STOKER SWUNG BACK TO ALLOW FIRE TO BE CLEANED

Steam is admitted to one side of the piston which drives the ram, by means of a very rapidly acting valve in much the same manner that air is admitted behind the piston of a pneumatic hammer. Thus, rapid acceleration is obtained. At the end of the blow, the piston is cushioned by a small quantity of steam trapped in the end of the cylinder so that there is no mechanical shock when bringing the ram to rest for the return stroke.

By means of a simple and easily adjusted throttling mechanism, the pressure of the steam admitted behind the piston is successively varied so that strokes or blows of 4 different intensities are secured. Hence, the first or weakest stroke delivers a charge of coal over the first or front quarter of the fuel bed; the second stroke delivers to the second quarter, and so on. The spreading of the coal is accomplished by means of the distributor plate, D, Figs. 3 and 4.

The exhaust from the ram cylinder is led to a ⅜ by 3-in. rectangular nozzle at F, Figs. 3 and 4. Events are so timed that a blast of exhaust steam emerges at

F at the same instant that a flying charge of coal reaches the distributor plate. Consequently, the steam catches, partly carries, and assists in spreading the coal over the various portions of the fuel bed. It will be noted that the intensity of the blasts of exhaust steam vary in the same manner and directly with the intensity

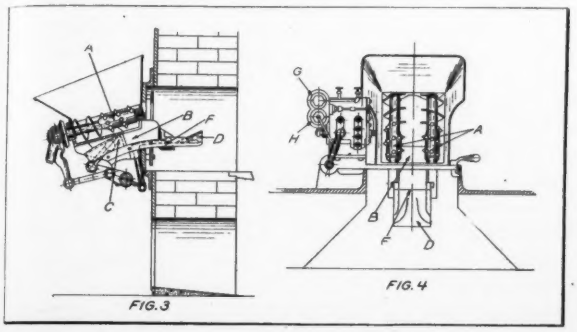
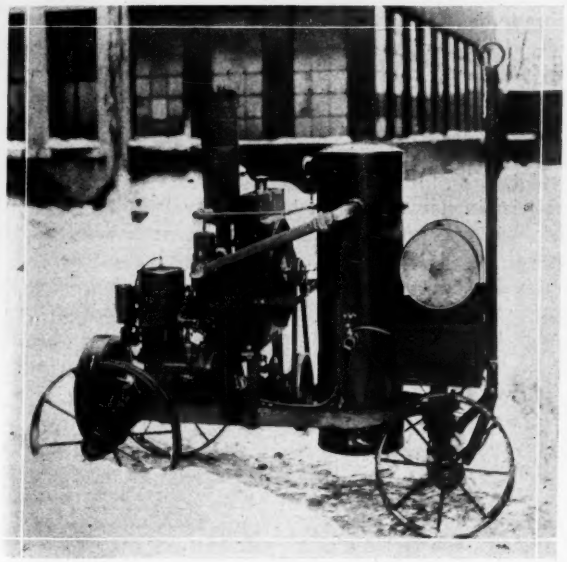



FIG. 3. VERTICAL SECTION OF STOKER
FIG. 4. HORIZONTAL SECTION

of the stroke of the ram. The character of the spreading depends upon the contour of the distributor plate, D, which is varied to suit furnaces of different shapes and proportions.

Fluctuations in the demand on the boiler are accommodated by varying the number of charges of coal thrown per minute and by varying the size of the individual charge; the former is the principal method em-



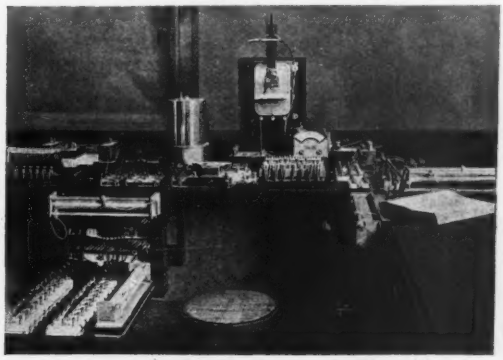
INGERSOLL-RAND PORTABLE AIR COMPRESSOR

ployed, while the latter is resorted to only in cases of extreme variation. This change in speed is accomplished by means of a small steam pilot piston, G, the speed of which is controlled by a water-resistance piston, H, to which it is yoked. The resistance of the water piston is varied by constricting or enlarging the passage through which the water is forced to flow from one end of the cylinder to the other. Because of this arrangement, both hand and automatic control are easily accomplished.

This stoker is manufactured by the Kincaid Stoker Co., Cincinnati, Ohio.

## Permeability Testing Outfit

AN outfit used for obtaining magnetization curves and hysteresis loops of straight rods, sheet-metal strips, transformers, and other working samples of magnetic material has recently been placed on the market. The complete equipment is a combination of a ballast galvanometer, adjustable mutual inductance, resistors, batteries, switches and sample holding yokes.



PERMEABILITY TESTING OUTFIT

The apparatus required for making tests consists of a ballastic galvanometer, adjustable mutual inductance switches, resistors and 2 ammeters, a sample holding yoke for straight rods, and a sample holding yoke for sheet material. The illustration shows the complete outfit as manufactured by the Westinghouse Electric and Manufacturing Co.

## Small Portable Air Compressor

THE small gasoline engine driven portable air compressor illustrated here has been developed by the Ingersoll-Rand Co., particularly to meet the needs of the contractor doing work of a temporary character requiring compressed air in small quantities, such as the laying of gas and water mains, where air tools of various types are used, for cutting asphalt, tearing up roadways, rock cutting, calking lead joints, drilling and riveting on steel pipes, tamping dirt, etc. Compressed air tools have demonstrated their merit on this class of work and in every case have proved a considerable saving, both in time and labor, over hand methods.

The compressor, being portable and self contained, is admirably adapted to this work. It is operated by a simple single-cylinder gasoline engine which is coupled directly to the compressor, both pistons working on the same crank shaft. The engine is of the single-acting, 2-cycle type, closely following marine designs. The air compressor, which is one of this company's standard types, known as "Imperial XII," has a capacity of 45 cu. ft. a min. at a pressure of 90 lb.; it is fitted with

an air unloader and the engine with a centrifugal governor.

Cooling is provided for by a gear-driven pump and an automobile type radiator with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

The frame, axles and wheels are of steel, the front axle is arranged with a swivel connection to the frame, permitting horizontal rotation for turning corners and sufficient vertical movement to accommodate the wheels to inequalities of the road without strain on the frame.

An air receiver tested to 300 lb. water pressure and fitted with safety valve, pressure gage, necessary piping, outlets, etc., is hung at one end of the frame and a gasoline tank of 15 gal. capacity is supported on a large tool box as shown in the illustration.

The outfit complete weighs 1600 lb.; it is designed for hand transportation but can be fitted with tongue and singletree if desired.

# News Notes

HEREWITH IS LIKENESS of Charles A. Hopper, recently deceased, who was associated with Keystone Lubricating Co., soon after its formation by A. C. Busby, and came to have charge of the distribution to power

plants and mills. His loss will be keenly felt by the company and by the many friends that he made in the field.

THE BROWN INSTRUMENT CO. and Keystone Electrical Instrument Co. have removed their Philadelphia plant to Wayne Junction, Philadelphia, where a complete machine shop, laboratory and inspector's office has been installed.

MARCH 6 to 13, an Industrial Exposition to further the campaign and use of the slogan "Made in the U. S. A.," is to be held in the Grand Central Palace, New York. It is to be devoted to American-made and American-grown products, and is under the management of the National Exposition Co., of which Harry A. Cochrane is president, with offices in the 5th Ave. Bldg., New York.

ANOTHER BIG ice factory has been put into commission at San Benito, Tex., to take the place of one destroyed by fire last September. The plant has a capacity of 70 tons a day, about 1/5 being used for local trade and the rest for icing vegetable cars.

A. E. CARPENTER, head of the firm of E. F. Houghton & Co., died on Dec. 19, at his home, Spring Garden St., Philadelphia. Mr. Carpenter was born in Roxborough, May 12, 1829, and graduated from the theological department of Bucknell University, after attending public schools of his native town. Mr. Carpenter was always engaged in commercial pursuits, but served for many years as clergyman in various charitable institutions, and gave his services to churches that were not sufficiently prosperous to pay a salary. In 1870 he entered into partnership with E. F. Houghton and others, under the name of E. F. Houghton & Co., to manufacture products from petroleum. In accordance with the partnership agreement, Mr. Carpenter absorbed the interest of each partner of the original company as they died, until 1890, when he was sole proprietor of the company, which was incorporated in 1910, Mr. Carpenter being the principal stockholder. He is survived by a widow, 2 sons, Sergeant Thomas B. Carpenter, U. S. A., and Chas. E. Carpenter, of Philadelphia, and 2 daughters, Mrs. E. C. Buchanan, of Tampa, Fla., and Mrs. John L. Glendenning. Charles E. Carpenter will succeed to the presidency of the Houghton corporation.

SINCE IT HAS BEEN brought to the attention of the Best Mfg. Co., of Pittsburgh, Pa., that rumors were being circulated to the effect that the company intended retiring from the piping business, the Best Mfg. Co. wishes to deny these rumors emphatically and assure the trade which has known it for over 30 yr., that it is now and intends to continue in the future prosecuting aggressively the piping business.

U. S. CIVIL SERVICE COMMISSION announces an examination for marine engine and boiler draftsman, on Feb. 3 and 4, 1915, to fill a vacancy at $5.04 a day. In filling vacancies in navy yards and other naval establishments preference in certification will be given to eligibles residing in the vicinity of the place at which the vacancy occurs. The following subjects will have the relative weights indicated: Mathematics (including arithmetic, algebra to quadratics, geometry, plane trigonometry, and use of slide rule or logarithms), 15; materials, details, and specifications, 15; drawing and design, 30; education, training, and experience, 40. Applicants must have had a technical school education suitable for the position, or 4 yr. suitable practical experience, of which at least 1 yr. must have been employed in office drafting. Age, 18 yr. or over on the date of examination. Each applicant will be required to submit to the examiner on the day of examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312, stating the title, Marine Engine and Boiler Draftsman.

U. S. CIVIL SERVICE COMMISSION announces an examination for sanitary engineer, Feb. 2, 1915, to fill a vacancy in the Public Health Service for duty in the field, at a salary of $2500 a yr. Duties of this position will be to make studies of public health matters involving engineering problems, to advise in respect to purification of water supplies, sewage disposal, rat-proofing

construction and drainage, and to prepare plans and specifications for such projects. The following subjects will have the relative weights indicated: Education, 40; experience, 40; publications, 20. Graduation from a college or university of recognized standing, such instruction to have included full courses in sanitary engineering, and at least 4 yr. subsequent laboratory and field experience in sanitary engineering, including experience in antimalarial work, are prerequisites for consideration for this position. Applicants must not have reached their forty-fifth birthday on the date of examination. Apply at once for Forms 304 and 2095, stating the title, Sanitary engineer, Male.

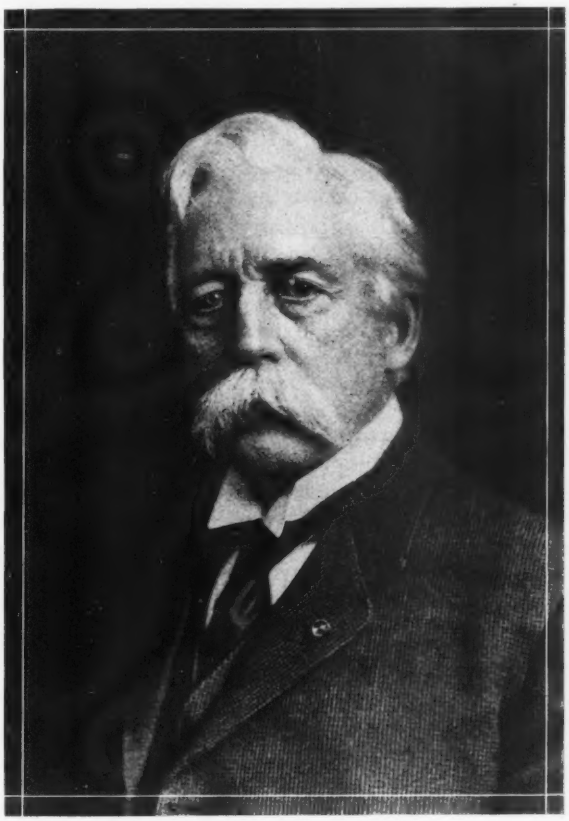
U. S. CIVIL SERVICE COMMISSION announces an examination for copyist marine engine and boiler draftsman, on Feb. 3, 1915, to fill a vacancy at $2.80 a day in the navy yard, Norfolk, Va. The following subjects will have the relative weights indicated: Mathematics (covering arithmetic, algebra to quadratics, plane and solid geometry, elements of plane trigonometry, and use of logarithm tables or a slide rule), 25; drawing and details of construction (covering engines, pumps, boilers, and the materials of which they are manufactured, and the making of drawings from sketches or descriptions), 45; education, training, and experience, 30. Applicants must have had a good common or high school education, including instruction in elementary mathematics and drawing. For positions at $2.80, they must have had at least 9 mo. experience in a drafting room. Age, 18 yr. or over on the date of the examination. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312, stating the title, Copyist Marine Engine and Boiler Draftsman (Male), to U. S. Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE COMMISSION announces an examination for junior topographer, on Feb. 4 and 5, 1915, to fill vacancies as they may occur in this position in the Geological Survey, at salaries ranging from $720 to $1200 a year. Appointment to permanent positions in the Geological Survey will be made from the register of junior topographer eligibles. An examination will be held on Feb. 3, 1915, to secure eligibles qualified as topographic aid, for temporary employment only, during the field season. An applicant who desires to be examined for both positions must file a separate application for each. Applicants must have reached their twentieth but not their thirtieth birthday on the date of the examination, except that in the case of men who have had 5 field seasons' experience in any Government bureau as technical field assistant doing topographic work similar to that executed by the Geological Survey, the maximum age limit is 35 yr. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces an examination for copyist ordnance draftsman, on Feb. 3, 1915, to fill a vacancy in the Navy Yard, Washington, D. C., at $2.80 a day. Age, 18 yr. or over. Apply for Form 1312.

# Edward Daniel Meier

COL. EDWARD DANIEL MEIER died recently of hardening of the arteries and heart disease, at the home of his daughter, Mrs. Wm. Schevill, 44 West 77th St., New York. Colonel Meier was Past President of the American Society of Mechanical Engineers, veteran of the Civil War, and one of the most eminent mechanical engineers of the country. He was born in St. Louis, Mo., May 30, 1841. At the close of a scientific course at Washington University, St. Louis, in 1858, he spent 4 yr. in Germany at the Royal Polytechnic College in Hanover, followed by an apprenticeship at



Mason's Locomotive Works, Taunton, N. J. In 1863 he enlisted in the Grey Reserves, the 32nd Pennsylvania, which was attached to the army of the Potomac until after the Battle of Gettysburg, and subsequently served in the 2nd Massachusetts Battery, also in the United States Engineer Corps, and finally became lieutenant in the First Louisiana Cavalry, seeing much active service, and on May 30, 1865, receiving the surrender of Lieutenant-General John B. Hood and staff.

At the close of the war, he entered the Rogers Locomotive Works, at Paterson, N. J., remaining 1 yr. From 1867 to 1870, he was associated with the Kansas Pacific Railway, first as assistant superintendent of machinery, keeping open its Western communications when the bridges were swept away, designing, building and operating a mill for sawing, planing and turning the soft magnesian limestones by machinery, designing machine and car shops, and subsequently becoming superintend-

ent of machinery. He resigned to become chief engineer of the Illinois Patent Coke Co., leaving there in 1872 to assume the secretaryship of the Meier Iron Co., and to build its blast furnaces. From 1873 to 1875 he directed the machinery department of the St. Louis Interstate Fair. During this time he became actively interested in the St. Louis cotton industry and was associated with the St. Louis Cotton Factory, and with the Peper Hydraulic Cotton Press, for both of which he designed machinery for compressing cotton. In 1884, he organized the Heine Safety Boiler Co. for the development in the United States of the water-tube boiler of that name, and has been its president and chief engineer ever since. He has also been responsible for the introduction of the Diesel engine into the United States and until 1908 was engineer-in-chief and treasurer of the American Diesel Engine Co.

Colonel Meier was lieutenant-colonel and later colonel of the First Regiment of the Missouri National Guard, serving about 10 yr., and a member of the Grand Army of the Republic and of the Loyal Legion. He has been active in a number of professional organizations, serving in 1881-1884 as treasurer of the St. Louis Engineer's Club, in 1889-1890 as its president and as secretary of the American Boiler Manufacturer's Association. It was in the latter capacity that he drew up the Uniform American Boiler Specifications of 1898. He was president of that organization and also of the Machinery and Metal Trades Association since 1908.

In the American Society of Mechanical Engineers he was active on many committees, was one of its managers from 1895 to 1898, and was twice elected vice-president, serving his first term from 1898 to 1900, and beginning the second in 1910, but resigning in the same year to assume the presidency.

In the summer of 1913, Colonel Meier represented the A. S. M. E. in a joint meeting with the German Engineering Society in Germany, the American party being about 300 in number, of which he was chairman and spokesman.

One of the last and most important of Colonel Meier's achievements in the field of engineering, was the design and installation of 10,000 hp. of boilers in the power house of the new Grand Central Terminal at 42nd St., New York City.

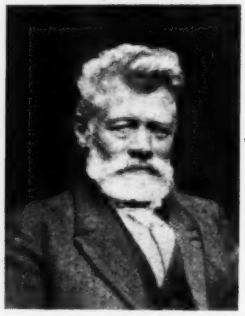
## Fred Ulrich

FRED ULRICH, general sales manager of the Vilter Manufacturing Co., Milwaukee, Wis., and one of the best known practical experts in the field of mechanical refrigeration, died Dec. 10, at his home, 2720 McKinley Boulevard, Milwaukee, Wis., after an illness of only a few days.

Mr. Ulrich was born in Apolda, Thueringen, Feb. 19, 1852, studied in the Gymnasium in Apolda, graduated from the Royal Institute of Technology in Chemnitz, Saxony, and later from the Polytechnic Institute in Karlsruhe.

In the capacity of mechanical engineer he was engaged by several large concerns in Germany for the design, sale, and supervision of large machinery installations in the Russian Empire, Finland, etc., also traveled extensively in Italy and other countries on the continent. In 1882, he came to America and was connected with concerns in Cincinnati, St. Louis, and Chicago until 1885, when he assumed the position of chief engineer of the Weisel & Vilter Mfg. Co., now the Vilter Manufacturing Co. In 1888 he became a stockholder and director of the company and later on general sales manager, which position he occupied at the time of his death.

During the 29 yr. continuous connection with the Vilter Manufacturing Co., he aided materially in developing the business from a comparatively small to one of the largest establishments of its kind in America.



In the performance of his duties he visited a great many of the ice-making and refrigerating plants in the United States and Mexico, and his wonderfully retentive memory enabled him to recall accurately small details years afterward. In the solution of all problems his highly trained, keen and observant mind was of invaluable assistance. He was thorough and conscientious in all business matters, always actuated by a high sense of honor and justice, and while generally inclined to be serious, there were flashes of dry humor which disclosed his deep insight into men and affairs. His demise is a distinct loss to his associates and the refrigerating world.

He is survived by his wife, two daughters and a son.

## Catalog Notes

HESS & BARKER, 236 S. 8th St., Philadelphia, is sending out its calendar for 1915.

PORTABLE TOOLS manufactured by Stow Mfg. Co., Binghamton, N. Y., are illustrated in Bulletin No. 400, just issued by the company.

THE LUNKENHEIMER CO., Cincinnati, O., has lately issued pamphlets relating to its "Clip" valves and "Ferrenewo" valves.

PISTON RING SIZES for automobiles, motor cycles, cycle cars, trucks, tractors and engines are given in a pamphlet from The Burd High Compression Ring Co., Rockford, Ill.

CLING-SURFACE CO., of Buffalo, has prepared a special calendar for engineers, particularly of interest to members of the N. A. S. E., and will be glad to mail copies free on request as long as the supply lasts.

LAGONDA MFG. CO., of Springfield, Ohio, has just issued a new bulletin, "Lagonda Boiler Tube Cleaners," illustrating and fully describing the new improved and interesting line of its apparatus. Copy is available upon request.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

## POWER TO PUMP WATER

| Total Head | | Horsepower for 100 Gal. per Min. | | Horsepower for 100 Cu. Ft. per Min. | |
|---|---|---|---|---|---|
| Lb. Per Sq. In. | Feet Head | Pump Eff. 55% | Theoretical Horsepower | Pump Eff. 55% | Theoretical Horsepower |
| 1 | 2.31 | 0.106 | 0.058 | 0.79 | 0.44 |
| 2 | 4.62 | 0.212 | 0.117 | 1.59 | 0.87 |
| 3 | 6.93 | 0.318 | 0.175 | 2.38 | 1.31 |
| 4 | 9.24 | 0.424 | 0.233 | 3.17 | 1.75 |
| 5 | 11.55 | 0.530 | 0.292 | 3.97 | 2.18 |
| 6 | 13.86 | 0.636 | 0.350 | 4.76 | 2.62 |
| 7 | 16.17 | 0.742 | 0.408 | 5.55 | 3.05 |
| 8 | 18.48 | 0.848 | 0.467 | 6.35 | 3.49 |
| 9 | 20.79 | 0.955 | 0.525 | 7.14 | 3.93 |
| 10 | 23.10 | 1.061 | 0.583 | 7.93 | 4.36 |
| 11 | | 1.167 | 0.642 | 8.73 | 4.80 |
| 12 | 27.72 | 1.273 | 0.700 | 9.52 | 5.24 |
| 13 | | 1.379 | 0.758 | 10.31 | 5.67 |
| 14 | 32.4 | 1.486 | 0.817 | 11.11 | 6.11 |
| 15 | | 1.591 | 0.875 | 11.90 | 6.55 |
| 16 | 37.0 | 1.697 | 0.933 | 12.69 | 6.98 |
| 17 | | 1.803 | 0.992 | 13.49 | 7.42 |
| 18 | 41.6 | 1.909 | 1.050 | 14.28 | 7.85 |
| 19 | | 2.015 | 1.108 | 15.07 | 8.29 |
| 20 | 46.2 | 2.121 | 1.167 | 15.87 | 8.73 |
| 21 | | 2.227 | 1.225 | 16.66 | 9.16 |
| 22 | | 2.333 | 1.283 | 17.45 | 9.60 |
| 23 | | 2.439 | 1.342 | 18.25 | 10.04 |
| 24 | | 2.545 | 1.400 | 19.04 | 10.47 |
| 25 | 57.7 | 2.652 | 1.458 | 19.84 | 10.91 |
| 26 | | 2.758 | 1.517 | 20.63 | 11.35 |
| 27 | | 2.864 | 1.575 | 21.42 | 11.78 |
| 28 | | 2.970 | 1.633 | 22.22 | 12.22 |
| 29 | | 3.076 | 1.692 | 23.01 | 12.65 |
| 30 | 69.3 | 3.182 | 1.750 | 23.80 | 13.09 |
| 31 | | 3.288 | 1.808 | 24.60 | 13.53 |
| 32 | | 3.394 | 1.867 | 25.39 | 13.96 |
| 33 | | 3.500 | 1.925 | 26.18 | 14.40 |
| 34 | | 3.606 | 1.983 | 26.98 | 14.84 |
| 35 | 80.8 | 3.712 | 2.042 | 27.77 | 15.27 |
| 36 | | 3.818 | 2.100 | 28.56 | 15.71 |
| 37 | | 3.924 | 2.158 | 29.36 | 16.15 |
| 38 | | 4.030 | 2.217 | 30.15 | 16.58 |
| 39 | | 4.136 | 2.275 | 30.94 | 17.02 |
| 40 | 92.4 | 4.242 | 2.333 | 31.74 | 17.45 |
| 41 | | 4.348 | 2.392 | 32.53 | 17.89 |
| 42 | | 4.455 | 2.450 | 33.32 | 18.33 |
| 43 | | 4.561 | 2.508 | 34.12 | 18.76 |
| 44 | | 4.667 | 2.567 | 34.91 | 19.20 |
| 45 | 105.0 | 4.773 | 2.625 | 35.70 | 19.64 |
| 46 | | 4.879 | 2.683 | 36.50 | 20.07 |
| 47 | | 4.985 | 2.742 | 37.29 | 20.51 |
| 48 | | 5.091 | 2.800 | 38.08 | 20.95 |
| 49 | | 5.197 | 2.858 | 38.88 | 21.38 |
| 50 | 115.5 | 5.303 | 2.917 | 39.67 | 21.82 |

PRACTICAL ENGINEER

## COMMON BEARING METALS (HALSEY)

| Kind of Bearing | Proportion of Metal | | | | | | |
|---|---|---|---|---|---|---|---|
| | Tin | Lead | Zinc | Antimony | Copper | Bismuth | |
| Dynamos, high speed | 88 | 17 | | 8 | 3.5 | 0.5 | |
| Marine Engines | 77 | 78 | | 3 | 3 | | |
| Eccentric Straps | 5 | | | 15 | 2 | | |
| Main Bearings | 34 | 44 | 30 | 16 | 2.5 | 0.25 | |
| Slides | 63 | | | 2.5 | | | |
| Babbit, hard No. 1 | 80 | | | 10 | 10 | | |
| " No. 2 | 88 | | | 9 | 8 | | |
| " Medium | 100 | | | 10 | 10 | | |
| Universal Bearing | 6 | 78 | | 16 | 4 | | |
| Antifriction Castings | 24 | | 80 | | | 0.25 | |
| Copper Hardened | | | | 7 | 6 | | |
| Alloys Grade 1 | 77 | 17 | 17 | 6 | 6 | | |
| " " 2 | 77 | 7 | 77 | 7.5 | 6 | | |
| " " 3 | 17 | 17 | 77 | | 7 | | |
| " " 4 | 88.8 | | | | 3.7 | | |
| Navy Antifriction | 13 | 17 | | | 113 | | |
| Brass Engine | 7 | 7 | 4 | | 64 | | |
| " Locomotive | 25 | 1 | 5 | | 160 | | |
| Heavy Bearings | | 0.15 | 0.25 | | 6 | | |
| Munz Metal | | 0.31 | 2.93 | | 2.25 | | |
| Parsons White Brass | | 64.9 | 38.4 | | 59 | Iron 0.11 | |
| Tobin Bronze | | 2.16 | | | 90.52 | | |
| Manganese Bronze | | 9.58 | | | | | |
| White Metal | | 87.92 | | 12.08 | | | |
| Hard Lead | | 94.4 | | 6.03 | | | |

PRACTICAL ENGINEER

## POWER TO PUMP WATER

| Total Head | | Horsepower for 100 Gal. Per Min. | | Horsepower for 100 cu. ft. Per Min. | |
|---|---|---|---|---|---|
| Lb. Per Sq. In. | Feet Head | Pump Eff. 55% | Theoretical Horsepower | Pump Eff. 55% | Theoretical Horsepower |
| 152 | | 16.121 | 8.867 | 120.60 | 66.33 |
| 154 | | 16.333 | 8.983 | 122.18 | 67.20 |
| 156 | | 16.545 | 9.100 | 123.77 | 68.07 |
| 158 | | 16.757 | 9.217 | 125.36 | 68.95 |
| 160 | 369.6 | 16.970 | 9.333 | 126.94 | 69.82 |
| 162 | | 17.182 | 9.450 | 128.53 | 70.69 |
| 164 | | 17.394 | 9.567 | 130.12 | 71.56 |
| 166 | | 17.606 | 9.683 | 131.70 | 72.44 |
| 168 | | 17.818 | 9.800 | 133.29 | 73.31 |
| 170 | 392.7 | 18.030 | 9.917 | 134.88 | 74.18 |
| 172 | | 18.242 | 10.033 | 136.46 | 75.05 |
| 174 | | 18.454 | 10.150 | 138.05 | 75.93 |
| 176 | | 18.667 | 10.267 | 139.64 | 76.80 |
| 178 | | 18.879 | 10.383 | 141.22 | 77.67 |
| 180 | 415.8 | 19.091 | 10.500 | 142.81 | 78.55 |
| 182 | | 19.303 | 10.617 | 144.40 | 79.42 |
| 184 | | 19.515 | 10.733 | 145.98 | 80.29 |
| 186 | | 19.727 | 10.850 | 147.57 | 81.16 |
| 188 | | 19.939 | 10.967 | 149.16 | 82.04 |
| 190 | 438.9 | 20.151 | 11.083 | 150.74 | 82.91 |
| 192 | | 20.364 | 11.200 | 152.33 | 83.78 |
| 194 | | 20.576 | 11.317 | 153.92 | 84.65 |
| 196 | | 20.788 | 11.433 | 155.50 | 85.53 |
| 198 | | 21.000 | 11.550 | 157.09 | 86.40 |
| 200 | 462.0 | 21.212 | 11.667 | 158.68 | 87.27 |
| 202 | | 21.424 | 11.783 | 160.26 | 88.15 |
| 204 | | 21.636 | 11.900 | 161.85 | 89.02 |
| 206 | | 21.848 | 12.017 | 163.44 | 89.89 |
| 208 | | 22.060 | 12.133 | 165.02 | 90.76 |
| 210 | 485.1 | 22.273 | 12.250 | 166.61 | 91.64 |
| 212 | | 22.485 | 12.367 | 168.20 | 92.51 |
| 214 | | 22.697 | 12.483 | 169.79 | 93.38 |
| 216 | | 22.909 | 12.600 | 171.37 | 94.25 |
| 218 | | 23.121 | 12.717 | 172.96 | 95.13 |
| 220 | 508.2 | 23.333 | 12.833 | 174.55 | 96.00 |
| 222 | | 23.545 | 12.950 | 176.13 | 96.87 |
| 224 | | 23.757 | 13.067 | 177.72 | 97.75 |
| 226 | | 23.970 | 13.183 | 179.31 | 98.62 |
| 228 | | 24.182 | 13.300 | 180.89 | 99.49 |
| 230 | 531.3 | 24.394 | 13.417 | 182.48 | 100.36 |
| 232 | | 24.606 | 13.533 | 184.07 | 101.24 |
| 234 | | 24.818 | 13.650 | 185.65 | 102.11 |
| 236 | | 25.030 | 13.767 | 187.24 | 102.98 |
| 238 | | 25.242 | 13.883 | 188.83 | 103.85 |
| 240 | 554.4 | 25.454 | 14.000 | 190.41 | 104.73 |
| 242 | | 25.667 | 14.117 | 192.00 | 105.60 |
| 244 | | 25.879 | 14.233 | 193.59 | 106.47 |
| 246 | | 26.091 | 14.350 | 195.17 | 107.35 |
| 248 | | 26.303 | 14.467 | 196.76 | 108.22 |
| 250 | 577.0 | 26.515 | 14.583 | 198.35 | 109.09 |

PRACTICAL ENGINEER

## WEIGHT AND SPECIFIC GRAVITY OF VARIOUS SUBSTANCES

| SUBSTANCE | WT. PER CU. FT. LB. | WT. PER CU. IN. LB. | SPEC. GRAVITY | SP. HEAT B.T.U. PER LB. | FUSING POINT DEG. FAH. |
|---|---|---|---|---|---|
| *METALS* | | | | | |
| ALUMINUM | 166.5 | 0.0963 | 2.67 | 0.2158 | 1215 |
| ANTIMONY | 421.6 | 0.2439 | 6.76 | 0.0506 | 842 |
| BABBIT, AVERAGE | 454.0 | 0.263 | 7.31 | | |
| BISMUTH | 612.4 | 0.354 | 9.82 | 0.0301 | 510 |
| BRASS (CU. 80 + ZN. 20) | 536.3 | 0.3103 | 8.60 | | |
| BRASS (70 30) | 523.6 | 0.3031 | 8.40 | | |
| BRASS (60 40) | 521.3 | 0.3017 | 8.36 | 0.08831 | 1859 |
| BRASS (50 50) | 511.4 | 0.2959 | 8.20 | | |
| BRONZE (CU. 95 TO 80 TIN. 5 TO 20) | 552.09 | 0.3195 | 8.853 | | 1652 |
| COPPER, CAST | 537.77 | 0.312 | 8.625 | | |
| " , DRAWN | 556.79 | 0.322 | 8.93 | 0.0936 | 1922 |
| GOLD, PURE | 1209.6 | 0.700 | 19.34 | 0.0316 | 1915 |
| " , 20K. | 981.5 | 0.568 | 15.702 | | 1944 |
| GRAPHITE | 137.2 | 0.0795 | 2.20 | 0.2000 | |
| GUN METAL | 528. | 0.305 | 8.46 | | |
| IRON, CAST | 450. | 0.2604 | 7.218 | 0.1189 | 2500 |
| " , WROUGHT | 480. | 0.2779 | 7.70 | 0.1152 | 2910 |
| LEAD, CAST | 707.6 | 0.409 | 11.35 | | |
| " , ROLLED | 709.7 | 0.4106 | 11.38 | 0.0305 | 618 |
| MERCURY (32°) | 849.3 | 0.4915 | 13.62 | | |
| MERCURY (60°) | 846.8 | 0.4900 | 13.58 | 0.033 | -38 |
| MERCURY (212°) | 834.4 | 0.4828 | 13.36 | | |
| PLATINUM | 1347.0 | 0.7756 | 21.5 | 0.0324 | 3452 |
| SILVER, STANDARD | 655.1 | 0.3791 | 10.505 | 0.056 | 1750 |
| STEEL | 489.6 | 0.2834 | 7.854 | 0.1175 | 2507 |
| TIN | 458.3 | 0.2652 | 7.350 | 0.055 | 449 |
| TUNGSTEN | 1076.7 | 0.6243 | 17.3 | 0.0334 | 4000 |
| ZINC | 436.5 | 0.2526 | 7.0 | 0.0960 | 780 |
| *NON-METAL SOLIDS* | | | | | |
| ASPHALTUM | 87. | 0.0503 | 1.39 | | |
| BRICK | 118.5 | 0.0686 | 1.90 | 0.192 | |
| CHARCOAL | 27.5 | 0.016 | 0.441 | 0.2410 | |
| COAL, ANTHRACITE | 102.25 | 0.0592 | 1.640 | 0.201 | |
| " | 89.53 | 0.0518 | 1.436 | | |
| " , BITUMINOUS | 79.49 | 0.0460 | 1.270 | 0.241 | |
| COKE | 31.10 | 0.0181 | | 0.203 | |
| CONCRETE | 137. | 0.0795 | 2.20 | | |
| CORK | 14.96 | 0.0087 | .240 | | |
| EARTH, LOOSE | 76. | 0.044 | | | |
| " , CLAY | 135. | 0.0781 | | | |
| " , GRAVEL | 110. | 0.0636 | | | |

APPROXIMATE CUSTOMARY PRESSURES, POUNDS PER SQUARE INCH PROJECTED AREA (HALSEY)

| Machine | Kind of Bearing: Main Shaft | Crosshead Pin | Crank Pin | Step | Crosshead Slide | Thrust |
|---|---|---|---|---|---|---|
| Very Low Speed, Intermittent | 8500 | | | | | 325 |
| Punch Presses | 3500 | | | | | |
| Drill " | 100-150 | | | | | |
| Heavy Line Shaft, Bz. | 15-25 | | | | | |
| Light " " C.I. | | | | 2000 | 40-60 | |
| Heavy Slow Speed | 300-550 | 2000-4000 | 1400-1700 | | 50-80 | 50-70 |
| Locomotives | 300-500 | | 400-500 | | | |
| Marine Engines | | | | | 30-50 | |
| Stationary Engines | | | 800-1300 | Center Crank | | |
| Slow Speed | 200-400 | 1000-1500 | (400-600- | Overhung " | | |
| High Speed | 150-250 | 1000-1800 | (900-1500- | | | |
| Air Compressors | | | | | | |
| Straight Line Steam | 160-240 | 630-800 | 560-700) | Center Crank | | |
| " Belt | 120-230 | 400-800 | 240-400) | | | |
| " " Steam | 200-230 | 460-820 | 460-820) | Side " | | |
| " " Belt | 180-230 | 630-820 | 630-820) | | | |
| Gas Engines | 300-700 | 1300-2000 | 1300-1800 | | | 200-1000-Vertical |
| Steam Turbines | 40-60- | Horizontal | | | | |

POWER TO PUMP WATER

| Total Head | | Horsepower for 100 Gal. per Min. | | Horsepower for 100 Cu.Ft. per Min. | |
|---|---|---|---|---|---|
| Lb. Per Sq. In. | Feet Head | Pump Eff. 55% | Theoretical Horsepower | Pump Eff. 55% | Theoretical Horsepower |
| 52 | | 5.515 | 3.033 | 41.26 | 22.69 |
| 54 | | 5.727 | 3.150 | 42.84 | 23.56 |
| 56 | | 5.939 | 3.267 | 44.43 | 24.44 |
| 58 | | 6.152 | 3.383 | 46.02 | 25.31 |
| 60 | 138.6 | 6.364 | 3.500 | 47.60 | 26.18 |
| 62 | | 6.576 | 3.617 | 49.19 | 27.05 |
| 64 | | 6.788 | 3.733 | 50.78 | 27.93 |
| 66 | | 7.000 | 3.850 | 52.36 | 28.80 |
| 68 | | 7.212 | 3.967 | 53.95 | 29.67 |
| 70 | 161.7 | 7.424 | 4.083 | 55.54 | 30.55 |
| 72 | | 7.636 | 4.200 | 57.12 | 31.42 |
| 74 | | 7.848 | 4.317 | 58.71 | 32.29 |
| 76 | | 8.061 | 4.433 | 60.30 | 33.16 |
| 78 | | 8.273 | 4.550 | 61.89 | 34.04 |
| 80 | 184.8 | 8.485 | 4.667 | 63.47 | 34.91 |
| 82 | | 8.697 | 4.783 | 65.06 | 35.78 |
| 84 | | 8.909 | 4.900 | 66.65 | 36.65 |
| 86 | | 9.121 | 5.017 | 68.23 | 37.53 |
| 88 | | 9.333 | 5.133 | 69.82 | 38.40 |
| 90 | 207.9 | 9.545 | 5.250 | 71.41 | 39.27 |
| 92 | | 9.758 | 5.367 | 72.99 | 40.15 |
| 94 | | 9.970 | 5.483 | 74.58 | 41.02 |
| 96 | | 10.182 | 5.600 | 76.17 | 41.89 |
| 98 | | 10.394 | 5.717 | 77.75 | 42.76 |
| 100 | 231.0 | 10.606 | 5.833 | 79.34 | 43.64 |
| 102 | | 10.818 | 5.950 | 80.93 | 44.51 |
| 104 | | 11.030 | 6.067 | 82.51 | 45.38 |
| 106 | | 11.242 | 6.183 | 84.10 | 46.25 |
| 108 | | 11.454 | 6.300 | 85.69 | 47.13 |
| 110 | 254.1 | 11.667 | 6.417 | 87.27 | 48.00 |
| 112 | | 11.879 | 6.533 | 88.86 | 48.87 |
| 114 | | 12.091 | 6.650 | 90.45 | 49.75 |
| 116 | | 12.303 | 6.767 | 92.03 | 50.62 |
| 118 | | 12.515 | 6.883 | 93.62 | 51.49 |
| 120 | 277.2 | 12.727 | 7.000 | 95.21 | 52.36 |
| 122 | | 12.939 | 7.117 | 96.79 | 53.24 |
| 124 | | 13.151 | 7.233 | 98.38 | 54.11 |
| 126 | | 13.364 | 7.350 | 99.97 | 54.98 |
| 128 | | 13.576 | 7.467 | 101.55 | 55.85 |
| 130 | 300.3 | 13.788 | 7.583 | 103.14 | 56.73 |
| 132 | | 14.000 | 7.700 | 104.73 | 57.60 |
| 134 | | 14.212 | 7.817 | 106.31 | 58.47 |
| 136 | | 14.424 | 7.933 | 107.90 | 59.35 |
| 138 | | 14.636 | 8.050 | 109.49 | 60.22 |
| 140 | 323.4 | 14.848 | 8.167 | 111.07 | 61.09 |
| 142 | | 15.061 | 8.283 | 112.66 | 61.96 |
| 144 | | 15.273 | 8.400 | 114.25 | 62.84 |
| 146 | | 15.485 | 8.517 | 115.83 | 63.71 |
| 148 | | 15.697 | 8.633 | 117.42 | 64.58 |
| 150 | 346.5 | 15.909 | 8.750 | 119.01 | 65.45 |

WEIGHT AND SPECIFIC GRAVITY OF VARIOUS SUBSTANCES

| SUBSTANCE | WT. PER CU.FT. LB. | WT. PER CU.IN. LB. | SPEC. GRAV. | DEG. FAHR. | SP. HEAT B.T.U. PER LB. | FUSING POINT DEG. FAH. |
|---|---|---|---|---|---|---|
| NON-METAL SOLIDS | | | | | | |
| GLASS | 163.4 | 0.094 | 2.62 - | | .1988 | 1832 |
| ICE | 57. | 0.0331 | 0.917- | | .504 | 32 |
| LIME-QUICK-BULK | 52.37 | 0.0303 | 0.84 - | | | |
| MASONRY-RUBBLE | 149.6 | 0.0868 | 2.40 - | | | |
| MICA | 175. | 0.1011 | 2.80 - | | | |
| MORTAR-LIME | 95. | 0.0550 | 1.52 - | | | |
| PORTLAND CEMENT | 78. | 0.045 | 1.25 - | | | |
| RESIN | 66.6 | 0.039 | 1.07 - | | | |
| RUBBER | 58.172 | 0.034 | 0.933- | | | |
| SALT | 132.81 | 0.077 | 2.130- | | | |
| SAND | 99.76 | 0.0578 | 1.60 - | | | |
| SLATE | 166.60 | 0.0965 | 2.672- | | | |
| SULPHUR | 126.77 | 0.0734 | 2.033- | | 0.2026 | 239 |
| STONE-LIMESTONE | 198.72 | 0.115 | 3.180- | | | |
| " -SANDSTONE | 133.92 | 0.0775 | 2.143- | | | |
| TALLOW | 58.23 | 0.0338 | 0.934- | | | 92 |
| WAX | 60.5 | 0.0351 | 0.97 - | | | 142 - 154 |
| WOOD - HARD | 72.95 | 0.0423 | 1.170- | | 0.570 | |
| " - SOFT | 34.54 | 0.020 | 0.554- | | 0.467 | |
| LIQUIDS | | | | | | |
| ACID - HYDROCHLORIC | 74.5 | 0.0431 | 1.195 - 46 | | | |
| " - NITRIC | 95.39 | 0.0552 | 1.530 - 59 | | | |
| " - SULPHURIC | 114.35 | 0.0662 | 1.834 - 64 | | 0.335 | |
| ALCOHOL - GRAIN | 50.316 | 0.0291 | 0.807 - 32 | | 0.648 | |
| " - WOOD | 50.504 | 0.0292 | 0.810 - 32 | | 0.601 | |
| AMMONIA | 38.844 | 0.0225 | 0.623 - 32 | | | |
| GASOLINE | 45.952 | 0.0266 | 0.737 - 60 | | | |
| TAR | 62.35 | 0.0361 | 1.000 - | | | |
| TURPENTINE | 53.43 | 0.0315 | 0.873 - 61 | | 0.441 | 14 |
| VEGETABLE OIL | 57.736 | 0.0334 | 0.926 - 61 | | | |
| WATER | 62.355 | 0.03608 | 1.000 - 39 | | 1.000 | 32 |
| GASES | | WT. CU.FT. GRAINS | | | | |
| AIR | 0.08071 | 564.97 | 1.000 - 32 | | 0.2374 | |
| AMMONIA | 0.0475 | 332.5 | 0.589 - 32 | | 0.5228 | |
| HYDROGEN | 0.00559 | 38.13 | 0.0692 - 32 | | 3.4090 | |
| NITROGEN | 0.0783 | 548.1 | 0.9701 - 32 | | 0.2438 | |
| OXYGEN | 0.0892 | 624.4 | 1.105 - 32 | | 0.2175 | |

POWER TO PUMP WATER

| Total Head | | Horsepower for 100 Gal. Per Min. | | Horsepower for 100 Cu.Ft. Per Min. | |
|---|---|---|---|---|---|
| Lb. Per Sq. In. | Feet Head | Pump Eff. 55% | Theoretical Horsepower | Pump Eff. 55% | Theoretical Horsepower |
| 252 | | 26.727 | 14.700 | 199.93 | 109.96 |
| 254 | | 26.939 | 14.817 | 201.52 | 110.84 |
| 256 | | 27.151 | 14.933 | 203.11 | 111.71 |
| 258 | | 27.363 | 15.050 | 204.69 | 112.58 |
| 260 | 600.6 | 27.576 | 15.167 | 206.28 | 113.45 |
| 262 | | 27.788 | 15.283 | 207.87 | 114.33 |
| 264 | | 28.000 | 15.400 | 209.45 | 115.20 |
| 266 | | 28.212 | 15.517 | 211.04 | 116.07 |
| 268 | | 28.424 | 15.633 | 212.63 | 116.95 |
| 270 | 625.7 | 28.636 | 15.750 | 214.21 | 117.82 |
| 272 | | 28.848 | 15.867 | 215.80 | 118.69 |
| 274 | | 29.060 | 15.983 | 217.39 | 119.56 |
| 276 | | 29.273 | 16.100 | 218.98 | 120.44 |
| 278 | | 29.485 | 16.217 | 220.56 | 121.31 |
| 280 | 646.8 | 29.697 | 16.333 | 222.15 | 122.18 |
| 282 | | 29.909 | 16.450 | 223.74 | 123.05 |
| 284 | | 30.121 | 16.567 | 225.32 | 123.93 |
| 286 | | 30.333 | 16.683 | 226.91 | 124.80 |
| 288 | | 30.545 | 16.800 | 228.50 | 125.67 |
| 290 | 669.9 | 30.757 | 16.917 | 230.08 | 126.55 |
| 292 | | 30.970 | 17.033 | 231.67 | 127.42 |
| 294 | | 31.182 | 17.150 | 233.26 | 128.29 |
| 296 | | 31.394 | 17.267 | 234.84 | 129.16 |
| 298 | | 31.606 | 17.383 | 236.43 | 130.04 |
| 300 | 693.0 | 31.818 | 17.500 | 238.02 | 130.91 |
| 302 | | 32.030 | 17.617 | 239.60 | 131.78 |
| 304 | | 32.242 | 17.733 | 241.19 | 132.65 |
| 306 | | 32.454 | 17.850 | 242.78 | 133.53 |
| 308 | | 32.666 | 17.967 | 244.36 | 134.40 |
| 310 | 716.1 | 32.879 | 18.083 | 245.95 | 135.27 |
| 312 | | 33.091 | 18.200 | 247.54 | 136.15 |
| 314 | | 33.303 | 18.317 | 249.12 | 137.02 |
| 316 | | 33.515 | 18.433 | 250.71 | 137.89 |
| 318 | | 33.727 | 18.550 | 252.30 | 138.76 |
| 320 | 739.2 | 33.939 | 18.667 | 253.88 | 139.64 |
| 322 | | 34.151 | 18.783 | 255.47 | 140.51 |
| 324 | | 34.363 | 18.900 | 257.06 | 141.38 |
| 326 | | 34.576 | 19.017 | 258.64 | 142.25 |
| 328 | | 34.788 | 19.133 | 260.23 | 143.13 |
| 330 | 762.3 | 35.000 | 19.250 | 261.82 | 144.00 |
| 332 | | 35.212 | 19.367 | 263.40 | 144.87 |
| 334 | | 35.424 | 19.483 | 264.99 | 145.75 |
| 336 | | 35.636 | 19.600 | 266.58 | 146.62 |
| 338 | | 35.848 | 19.717 | 268.17 | 147.49 |
| 340 | 785.4 | 36.060 | 19.833 | 269.75 | 148.36 |
| 342 | | 36.273 | 19.950 | 271.34 | 149.24 |
| 344 | | 36.485 | 20.067 | 272.93 | 150.11 |
| 346 | | 36.697 | 20.183 | 274.51 | 150.98 |
| 348 | | 36.909 | 20.300 | 276.10 | 151.85 |
| 350 | 808.5 | 37.121 | 20.417 | 277.69 | 152.73 |

MEXICAN GRAPHITE PAINT, Its Uses and Users, is the subject of a book just published, treating on the use of graphite paint as a protective coating for all severely exposed metal or wood surfaces. The manufacturer is The United States Graphite Co., Saginaw, Mich.

A FEW OF the stages of manufacture from mining of ore to shipping of the finished product, are illustrated on the 1915 calendar of The Youngstown Sheet and Tube Co., Youngstown, O. The views include one of the company's iron ore mines and different departments of its works illustrating methods of manufacture and shipping.

FROM THE American Boiler Life Co., of Boston, Mass., we have a finely gotten up booklet entitled, "Steam Boilers and Boiler Feed Water," which emphasizes the need of avoiding scale-forming material, corrosive matter and oil in the boilers. Also, it explains the method of protection furnished by American Boiler Life, which is the forming of a thin skin over all heating surfaces, to which scale will not adhere but which is stated to prevent corrosion or pitting.

BUSCH-SULZER BROS.-Diesel Engine Co., of St. Louis, Mo., has published an interesting Test Bulletin, containing a record of tests conducted to determine the economy and efficiency of a Type A, 225-brake hp. Busch-Sulzer-Diesel engine, operating under fluctuating and steady loads.

The tests which were carried out by and under the direction of Dr. A. C. Scott showed an average fuel consumption of approximately 6 gal. of oil per 100 net brake hp.-hr., and as the oil cost $1.22 per bbl. of 42 gal., the fuel cost amounted to a trifle less than 1¾ mills per brake horsepower-hour.

Although the engine under test had been in operation 6 months, no adjustments of any kind, such as are usually resorted to in attempts to obtain either test results or more than average efficiency records, were made, thus obtaining actual conditions met with in a small central station or isolated plant.

THE GENERAL ELECTRIC CO. has just issued an attractive bulletin, No. 42,010, on the subject of Small Turbo-Generator Sets. It illustrates and describes in considerable detail the horizontal turbine sets of small capacities manufactured by the company. These machines are built in capacities ranging from 7 to 300 kw., direct current, and 100, 200 and 300 kw. alternating current, and are used largely for supplying light and power in mills, machine shops, laundries, bakeries, breweries, apartment houses, etc., as well as for train lighting. The turbines can be furnished for either condensing or noncondensing operation and, in general, for any steam pressure over 80 lb.

THE 1915 CATALOG, No. 10, received from the D. T. Williams Valve Co., of Cincinnati, O., is one of the finest and most complete summaries of steam specialties that one could desire. It is divided up conveniently into sections, containing the different kinds of specialties, and has in addition a complete alphabetical index, which constitutes Section A. Section No. 1 treats of brass valves, giving a full description of the construction of the Williams regrinding valve, and a pricelist of all the different types made, globes, gates, checks and special forms. Section 2 takes up iron body valves, giving a like complete treatment, and Section 3 treats of stop cocks of all sizes and for all purposes. Section 4 lists brass fittings, including fusible plugs and gage glasses; Section 5, miscellaneous specialties, such as water gages, steam gages, pressure regulators, etc. The sixth section gives the lubricating devices, including grease and oil cups, pumps and sight feeds, and Section 7 deals with steam traps, including the Cookson return trap, the bucket trap, float trap, condensation receiver, and various forms of installing these. Section 8 describes steam and oil separators of vertical and horizontal type, and also the automatic self-draining separators. Section 9 is a dimension list for all types of valves, cocks, fittings, traps and separators, giving complete installing dimensions for all sizes. In Section 10 is collected a convenient series of tables and useful data on metals, piping and pipe bends, belting, flow of steam and mathematical quantities. The complete catalog forms a book of 320 pages, substantially bound in cloth covers.

AMONG PUBLICATIONS recently issued by the Westinghouse Electric & Mfg. Co., are the following:

Lightning Protection for Cars, leaflet No. 3783, covers types MP and K lightning arresters for railway cars. These lightning arresters are of the equivalent spark gap type, and are thoroughly illustrated and described in the leaflet.

Direct-Current Motors for Driving Job Printing Presses, is the title of leaflet No. 3707, which describes the characteristics of motors necessary for this kind of work. Different types of motors are also shown and described.

Westinghouse Low-Pressure Turbines, leaflet 2485-A, gives the classification of low-pressure turbine installation according to the service in which they are used. Brief descriptions are given of the different classes of service, and the type of load handled by each.

Large Slip-Ring Induction Motors, leaflet 3781, describes the type of motor designed for driving hoists, cranes, and similar applications where operation is not continuous, but consists of intermittent loads calling for high torque. The motors are illustrated and described in detail.

Motor-Driven Bakers' and Confectioners' Machinery, Section 3141, is the title of a well arranged pamphlet with an art cover, dealing with the use of motors for this class of service, and the particular advantages derived by the use of electric drive are explained. In addition, tables are shown giving the horsepower rating for the different classes of machines, and also describes a typical installation showing the kw. hr. consumption of each machine.

CALENDAR FOR 1915 has just been received from The Bird-Archer Co., 90 West St., New York, manufacturer of boiler chemicals.

A NEW CIRCULAR from Jenkins Bros., 80 White St., New York, illustrates and describes some types of the company's brass gate valves.

WESTINGHOUSE DIRECT-CURRENT MOTORS for Group Drive of Sewing Machines are illustrated and described in leaflet 3519-A, which deals with the use of motor drive for sewing machines in factories.

Small Motors No. 21, deals with the characteristics of this type of motor for alternating and direct-current work. A number of views showing detail parts and the completed motor are shown. One particularly interesting view is that illustrating the ventilation of this type of motor, as demonstrated by placing a piece of smouldering cotton waste near the motor when it is running. The strong cooling currents generated by the motor prevent injury to the insulation.

Folder 4292 covers watthour meters and explains their adaptability to central station service. Detail views are shown and full description of this type of meter is given.

"For Better Projection" is the title of folder 4205-A, covering the use of Cooper Hewitt rectifiers for moving picture service. The latest developments in this rectifier are shown, and reasons for its adoption by moving pictures are illustrated.

Leaflet 3523, covering Westinghouse No. 328 railway motors, describes this type of motor, detail views of its construction being shown, and its advantages described in detail. This type of motor is particularly adapted to city and light interurban service where an effort is made to use a car of exceptionally light weight and small wheels.

Leaflet 3784 describes the new type of control recently brought out by the Westinghouse Electric & Mfg. Co., known as PK. This control arrangement is especially adapted for standard K controllers, and has been adopted by a large number of traction systems.

# Trade Notes

THE WM. POWELL CO., of Cincinnati, Ohio, has completed 68 yr. of useful activity in the field of brass specialty and valve manufacture, and therefore adds a star to the number which it uses to signify its years of service, and the fact that it manufactures White Star valves.

A NEW composition disc for steam service has been perfected in the rubber factory of Jenkins Bros. at Elizabeth, N. J., and will hereafter be used in all Jenkins Bros. standard pattern globe, angle, cross and radiator valves.

This disc, which will be known as the Jenkins Bros. Disc No. 119, is of a hard composition which becomes tough and flexible when in service. It shows freedom from cracking and flaking and is durable under steam pressures up to 150 lb.

IN THE ANNUAL REPORT of the Northern Equipment Co., of Erie, Pa., sales of the Copes boiler feed water regulator and the Copes pump governor for 1914 are reported to exceed the best previous year by 9½ per cent. This has necessitated larger quarters, and to provide these, the plant equipment and business of the Erie Pump & Engine Works has been purchased. J. H. Dougherty, formerly with the International Steam Pump Co., will take charge of centrifugal pump design, and will improve and extend the line of Erie centrifugals. The new combination will be known as the Erie Pump & Equipment Co., officers being E. W. Nick, Pres. and Treas., D. H. DuMond, Vice-Pres., V. V. Veenschoten, Secretary.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

## ADVERTISING RATES
### Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

### Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000.

**Technical Publishing Co.**
**537 S. Dearborn Street**
**Chicago**

## Position Wanted

POSITION WANTED—By engineer, with first-class Canadian certificate, 14 years' experience. Familiar with any high speed, or Corliss engine; d.c. machines, air compressors, etc. Would take position as second in large power plant. Willing to go anywhere in Canada. Total abstainer. Excellent references. Address Box 378, Practical Engineer, Chicago, Ill. 1-15-1

POSITION WANTED—As Manager or Superintendent of an Electric Light Plant or Light and Water Works plant. Fifteen years' practical experience. Seven years' successful experience as manager of light and water plant. Know how to operate economically public service plants and how to maintain same. 38 years old; married. Strictly sober. A1 references. Could begin any time. Satisfaction guaranteed. Address W. Z. Champion, 809 Austin Ave., Brownwood, Texas. 1-15-1

POSITION WANTED—As chief engineer and electrician; 25 years' experience with steam and electrical equipments, and "Diesel Engines," accustomed to the economical management of power plants and their maintenance; erecting engineering experience; good all round mechanic and electrician; age 44; married; strictly sober; best of reference; correspondence solicited. Address Leonard Miller, 100 Greenleaf St., Brownwood, Texas. 1-15-1

POSITION WANTED—As Chief Engineer and Electrician; 12 years' experience as chief engineer, electrician and erector of steam and electrical apparatus. Also some refrigerating experience. Age 29. Married. Strictly sober. Can furnish best of references. Can start Jan. 15. Correspondence invited. S. James Zucchet, 1437 Solon Place, Chicago, Ill. 1-15-1

POSITION WANTED—As Chief Engineer of steam or hydro-electric power plant of 1000 hp. or less. 15 years' experience in central station operation; strictly temperate; best of reference as to character and ability. Middle West preferred. Address Box 376, Practical Engineer. 1-15-1

POSITION WANTED—By Sales Engineer with wide experience in selling Steam Engines, Boilers and Power Plant Equipment. Have shop experience and technical education. Can produce results. Address Practical Engineer, Box 379, Chicago, Ill. 1-15-1

POSITION WANTED—By engineer of 35, married, as fireman, assistant engineer or charge of small steam plant. Good repair man. Sober and steady. Will go anywhere in western states. Address Practical Engineer, Box 380, Chicago, Ill. 1-15-1

## Wanted

AN OPPORTUNITY for High Class Salesman. A well known, established concern, manufacturing power plant specialties, wants representatives in the following territories: Syracuse, N. Y.; Louisville, Ky.; Tacoma, Wash.; Birmingham, Ala.; Raleigh, N. C.; Nashville, Tenn.; Duluth, Minn.; Cincinnati, O.; Denver,, Colo. Applicants must be able to show good selling record and possess a knowledge of boiler equipment. Excellent opportunity for high class men. Details of experience and references in first letter. Box 375, Practical Engineer, Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

## Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company. Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

## For Sale

FOR SALE—25 kw. Holtzer Cabot d.c. generator with switchboard; A-1 condition. Lucas & Son, Bridgeport, Conn. 12-15-3

FOR SALE CHEAP—One Second-Hand Buckeye Engine; 125 h.p.; 9-ft. x 15-in. Band Wheel. Good condition. Appleton Mfg. Co., Batavia, Ill. 1-15-2

37½ K.W. G.E. 250-volt generator, dir. con. Ideal engine, with switchboard, $650; 50 h.p. Allis Corliss engine, $350; 200 h.p. Hughes & Phillips Corliss engine, with tangye frame, $900; 275 h.p. Vilter Corliss engine, $700; 600 h.p. Hamilton Corliss engine, $1200. Duzets & Son, 50 Church St., New York, N. Y. tf

## Patents and Patent Attorneys

PATENTS SECURED OR FEE RETURNED—Send sketch for free search, advice and report. Latest and most complete patent book ever published for free distribution. George P. Kimmel, Attorney, 226 Barrister Building, Washington, D. C. 12-15-6

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Books, 100 Mechanical Movements and Full Information Free. Expert Service. Best Terms. Write today. Fred G. Dieterich & Co., Patent Lawyers, 606 Ouray Bldg., Washington, D. C. 1-1-3

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

## Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscription (not your own) to Practical Engineer. Gilt edges; bound in leather.

## Miscellaneous

WANTED reliable commission selling agents in various States and also Canada to handle powder boiler compounds. Also a superior article, called "Cleaner," which can be most extensively consumed. Address James E. Dale Company, Rahway, N. J. 12-1-4

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

# *Sparks From The Advertising Pages*

Let's be frank.

After all is said and done, the fact remains that the costs of marketing any product are borne by you — the consumer.

The selling price includes the cost of production, the cost of selling and a profit to the manufacturer.

It could not be otherwise.

Sometimes, salesmen and even manufacturers boast that they do no advertising. They tell you this as an argument for their claim of low price.

As a matter of fact, they do some advertising — every firm that has a catalogue, envelope, letter head or other printed matter, advertises to some degree.

But let's take up the price and the selling cost question.

How much time does the salesman use in explaining the construction, uses, accomplishments, etc., of power plant equipment?

How much time does he use making calls where the buyer will not see him, because he—the buyer—has never heard of the product?

How much salary is the salesman paid?

Usually where added to his expense it totals a considerable figure.

The time used and **wasted** by the salesman of an unadvertised article in endeavoring to obtain an interview and in making that article known to purchasers and non-purchasers turns into a big, round sum in a year's time.

Somebody has to pay that cost. The manufacturer does not, because he is in business for a profit. **You pay it.** The cost of all this waste of effort is taken care of by the excessive margin of profit, included in the selling price.

Besides it's such a snaily, musty method of growing a business.

While the salesman is explaining to one engineer about his product, the printed advertisement could explain it to a thousand — all that would read it.

While the salesman is gaining ten customers for his firm by his sole personal efforts, the printed advertisement could gain a thousand and more.

And the faster a manufacturing firm grows, and the larger the quantity of their product that is sold, the quicker they can add to their manufacturing facilities. They can arrange for a quantity production at a much lower **unit** cost.

Summed up then, the printed advertisement sells the product quicker, at a lower selling expense, and brings the manufacturer the quantity production that enables him to make his product at a lower cost.

This is well to remember, and the next time a salesman for an unadvertised product comes into your office, ask him why his firm does not advertise in Practical Engineer.

Ask him why it does not take the shortest and least expensive method to reach you.

Ask him why it does not patronize the paper which gives you, for a dollar a year, more solid information on engineering subjects than you could purchase in book form for a hundred times that amount.